NV-
SPS-2

Nevada Department of Transportation

Materials Sampling, Field Testing and Laboratory Testing Plan

Strategic Highway Research Program

SPS-2 Experimental Projects

Interstate Highway No. I-80

Humboldt & Lander Counties

Nevada

FINAL

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I. INTRODUCTION

The Strategic Highway Research Program (SHRP) SPS-2 experiment was designed to study the structural factors involved in rigid pavement design. The objective of this study is to more precisely determine the relative influence of the strategic factors that affect the performance of rigid pavements. The primary factors addressed in this study include drainage, base type, concrete strength and thickness, and lane width. The study objective includes a determination of the influence of environmental region and soil type on these factors.

This report covers the construction of the SPS-2 experimental test sections on I-80 in Humboldt and Lander Counties, Nevada, constructed between May 1995 and August 1995. Section II gives an overall project description. Sections III, IV, and V pertain to the SPS-2 construction, discussing the materials and construction procedures used for each type of material, summarizing the construction activities, and noting key observations.

II. SPS-2 PROJECT DESCRIPTION

PHYSICAL ATTRIBUTES

The Nevada SPS-2 project is located in north central Nevada, approximately five miles west of Battle Mountain, in the outer eastbound lane of Interstate 80, as shown in figure 1. The SPS-2 sections extend from station 1596+65 to station 64+50 (milepost 223.7).

The construction work on this segment of I-80 consisted of removing the existing asphalt concrete (AC) surfacing, cement treated base, dense graded aggregate base, and embankment. The original subgrade was stabilized with lime and the embankment was replaced. The SHRP structural sections were then placed on top of the embankment.

The terrain surrounding the test sections is generally flat with minimal ground cover.

The elevation of the test sections is 4195 ft with a latitude of 40°42' N, and a longitude of 117°01' W.

CLIMATE

The location of the test site is classified by LTPP to be in the dry-freeze zone. Based upon climatic information collected at a Battle Mountain weather station from 1961 to 1990, the average yearly high temperature was 103°F, the average yearly low temperature was -14°F, and the average yearly precipitation was 8.23 in.

EXISTING SOIL

The soil in this area varied throughout the project.

The Nevada SPS-2 project fills the dry-freeze, course subgrade categories in table 2. This table list the pavement structural combinations for all SPS-2 projects.

TRAFFIC

Traffic data collected at GPS site 323010 near Wells, Nevada, approximately 120 mi east of the Nevada SPS-2 site is as follows:

Years	Average Annual Truck Volume SHRP Lane	Average Annual ESALs in SHRP Lane	% Truck Volume in SHRP Lane
1990-1992	302,000	799,000	52

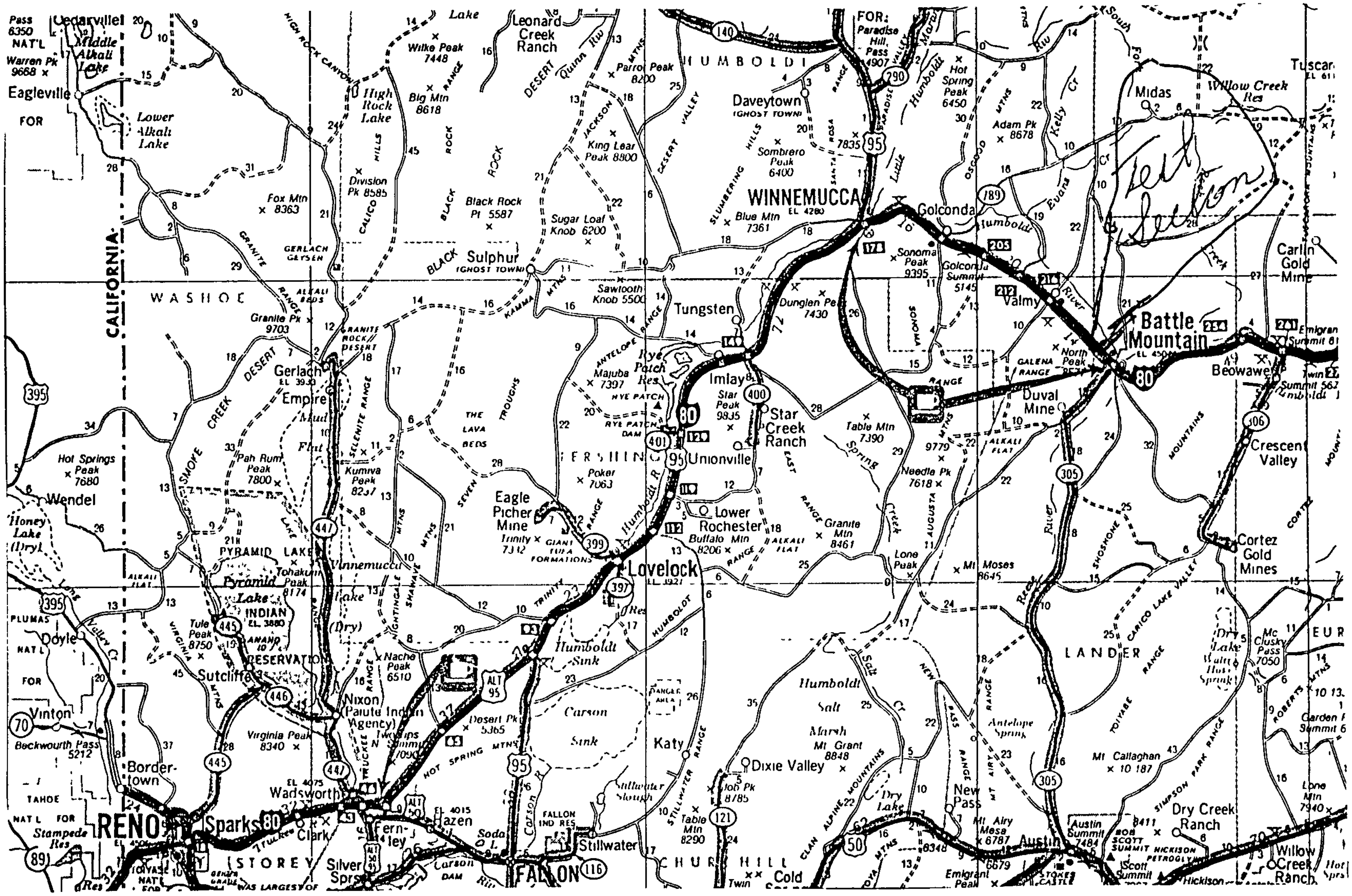


Figure 1. Location of NV SPS-2 projects.

Table 1. SPS-2 pavement structural combinations.

Pavement Structure					Climate Zones, Subgrade Site															
Drain	Base Type	PCC		Lane Width	Wet								Dry							
					Freeze				No Freeze				Freeze				No Freeze			
		Thick in	Strength psi		Fine		Coarse		Fine		Coarse		Fine		Coarse		Fine		Coarse	
					J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
No	DGAB	8	550	12	J1		L1		N1		P1		R1		T1		V1		X1	
				14		K13		M13		O13		Q13		S13		U13		W13		Y13
			900	12		K14		M14		O14		Q14		S14		U14		W14		Y14
				14	J2		L2		N2		P2		R2		T2		V2		X2	
		11	550	12		K15		M15		O15		Q15		S15		U15		W15		Y15
				14	J3		L3		N3		P3		R3		T3		V3		X3	
			900	12	J4		L4		N4		P4		R4		T4		V4		X4	
				14		K16		M16		O16		Q16		S16		U16		W16		Y16
No	LCB	8	550	12	J5		L5		N5		P5		R5		T5		V5		X5	
				14		K17		M17		O17		Q17		S17		U17		W17		Y17
			900	12		K18		M18		O18		Q18		S18		U18		W18		Y18
				14	J6		L6		N6		P6		R6		T6		V6		X6	
		11	550	12		K19		M19		O19		Q19		S19		U19		W19		Y19
				14	J7		L7		N7		P7		R7		T7		V7		X7	
			900	12	J8		L8		N8		P8		R8		T8		V8		X8	
				14		K20		M20		O20		Q20		S20		U20		W20		Y20
Yes	PATB DGAB	8	550	12	J9		L9		N9		P9		R9		T9		V9		X9	
				14		K21		M21		O21		Q21		S21		U21		W21		Y21
			900	12		K22		M22		O22		Q22		S22		U22		W22		Y22
				14	J10		L10		N10		P10		R10		T10		V10		X10	
		11	550	12		K23		M23		O23		Q23		S23		U23		W23		Y23
				14	J11		L11		N11		P11		R11		T11		V11		X11	
			900	12	J12		L12		N12		P12		R12		T12		V12		X12	
				14		K24		M24		O24		Q24		S24		U24		W24		Y24

· Nevada SPS-2

BASE CODES:
DGAB = Dense graded untreated aggregate base
LCB = Lean concrete base
PATB/DGAB = 4" Permeable asphalt treated base on 4" dense graded aggregate base
All perpendicular doweled joints at 15' spacing

GEOMETRICS

All test sections are situated on a horizontally straight section of I-80. Vertically, the grade varies from a minimum of -0.06 percent to a maximum of -0.3 percent. A positive grade, or small hill, was present from station 37+00 to station 53+00, between sections 320202 and 320206. The transverse slope throughout the project was two percent, sloping to the outer edge.

PROJECT PERSONNEL

Key personnel on the project included John McKenzi, Resident Engineer, and Bill Scott, Assistant Research Engineer, of Nevada DOT, John Maddick, Superintendent, of Maddick Construction Co., and Chuck Hicks and Pete Pradere of Nichols Consulting Engineers representing the Western Regional Office for LTPP.

III. NEVADA SPS-2 CONSTRUCTION

The SHRP SPS-2 experiment consists of the construction of twelve sections of Portland cement concrete (PCC) surface layers of varying widths, thicknesses, design strengths, and base layers of varying thickness and material type. These are shown as sections 320201 through 320212 in figure 2. For this project, one supplemental state section was included. This is shown as section 320259 in figure 2, and consisted of a 1.5 in leveling course over the existing AC, and a 10.5 in PCC surface layer. This was the state standard design for the remainder of the project.

SUBGRADE/EMBANKMENT

Materials

As this project was constructed over an existing section of highway, removal of the existing AC layer was necessary. Upon this removal, there were problems that will be discussed in the following sections. To correct these problems, a layer of lime stabilized soil was placed, topped by a layer of granular material to produce a suitable subbase for the test sections.

Natural Subgrade, Embankment Soil Classification

Based on laboratory testing, the natural subgrade was primarily a sandy silt. The percentage of clay ranged from 4.5 to 13.9.

Equipment and Construction Methods

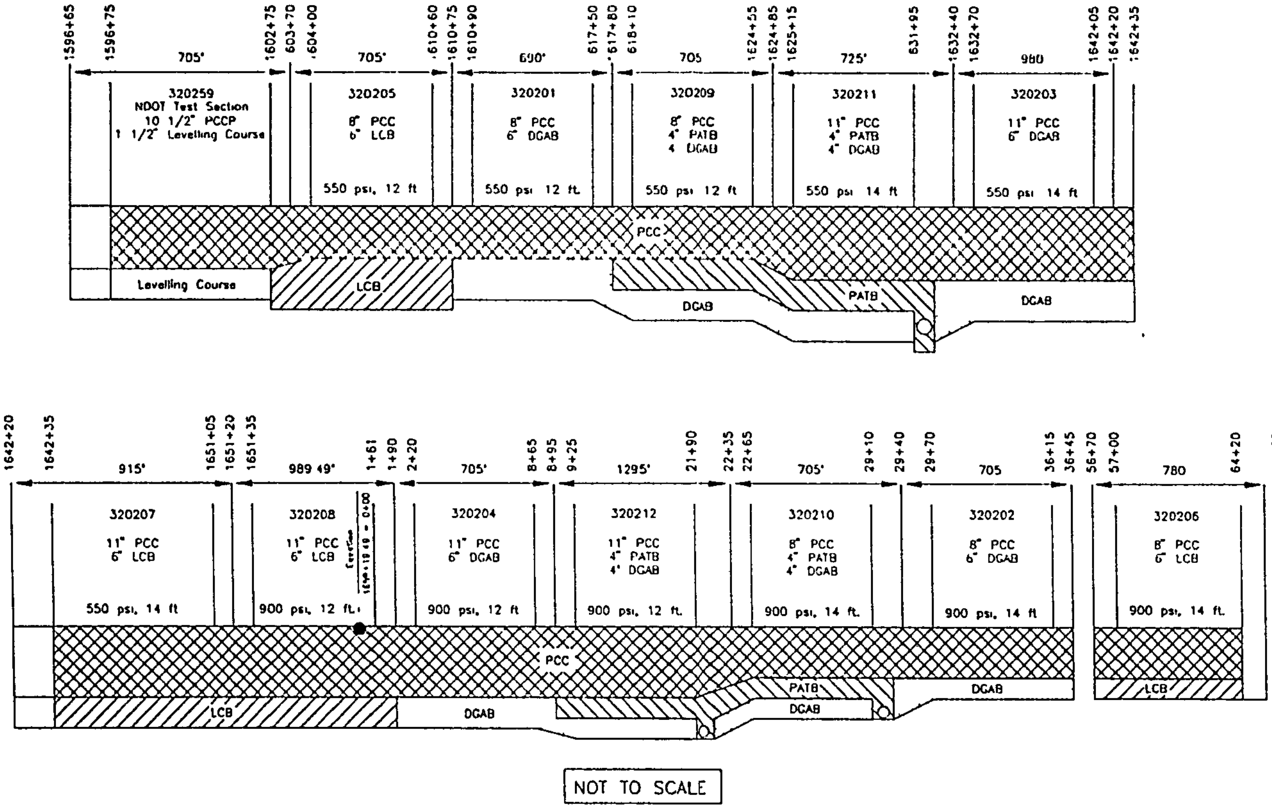
Roadway Excavation

The original AC layer was milled and removed and the millings were placed on the outer shoulder. This took place in May 1995. Following the AC removal, 8 in of cement-treated base and 8 in of dense graded aggregate base were rotomilled and piled on the outer shoulder. Two paddlewheel scrapers were then used to remove the remaining embankment material to a depth of 38 in. The embankment material was removed from the site.

At this point the subgrade material was determined to be unsuitable, since it did not meet the NDOT specifications for subbase material. NDOT determined that lime soil stabilization would provide a suitable subgrade material and confirmed with LTPP personnel that this would not affect the experiment.

Soil Stabilization

The stabilization operations began on May 31, 1995. Culp Soil Stabilization, Inc. performed the stabilization. Hydrated lime was spread and mixed at three percent by volume of soil, 1 ft deep into the unsuitable material. A 1993 CMI RS-500 Mixer/Pulverizer was used to mix the



PCC – Portland Cement Concrete Pavement
PATB – Permeable Asphalt Treated Base
DGAB – Dense Graded Aggregate Base
LCB – Lean Concrete Base
– Transverse Drain

Figure 2. Layout of experimental test sections, NV SPS-2 project, I-80.

lime to the depth of 1 ft, operating at a rate of 80 ft/min. Water was added during the mixing process. The lime particle size was 3/8 in, and after the first pass of the mixer, the particles were not totally dissolved. The mixer made additional passes in order to completely dissolve the lime particles. A motor grader was utilized to finish the subgrade surface to within 1/2 in tolerance. A trimming machine was utilized for finished grade. For the first 2400 ft of the project going east, a 38 ft width of roadway was excavated, lime treated, and filled. For the remainder of the project, the right hand (SHRP) lane was excavated 22 ft wide, stabilized and filled, then the passing lane was excavated, stabilized, and filled.

Fill Operations

Fill operations began on June 6, 1995. The process started by pushing the CTB/DGAB stockpile from the right shoulder into the area that was excavated. The lifts were compacted in 6 in to 8 in thicknesses with a Catepillar 815 equipped with a sheepsfoot roller. Two Catepillar 14G graders and one 140G grader were used to level the fill prior compaction. Water was applied with a 6000 gal water truck periodically during the fill operation.

Borrow was brought to the site using double belly dumps to bring the fill to the finished subgrade line. One Catepillar 14G grader was used for grading. A rubber-tired roller was used for compaction. The borrow was obtained from a stockpile located at the plant. The plant was located at the Negro Pit (NDOT designation 83-6) near Battle Mountain. Moisture contents and density tests were performed during the entire fill operation to ensure proper compaction. If sections of fill did not meet compaction or moisture specifications, then they were reworked until they met the specifications.

Quality Assurance Sampling and Testing

Prior to soil stabilization, sampling and testing of the natural subgrade was performed as shown in figure A1, appendix A. Sampling and testing was performed on the embankment as shown in figure A2, appendix A. Densities taken on the subgrade and embankment are given in tables 2 and 3, respectively.

FWD Testing

FWD testing was performed on June 14 and 15, 1995 on the lime treated subgrade. FWD testing on the embankment was performed from June 20-30, 1995. Only the first four sections, 320105, 320101, 320109, and 320111 were tested on top of the lime treated subgrade. The remaining sections were covered up with embankment material prior to FWD testing.

Deflection plots for each section are shown in appendix B. Tables 4 and 5 list the deflection averages and standard deviations for the subgrade and embankment. Figure 3 shows the plot of the average deflections for both the subgrade and embankment.

Table 2. Subgrade

Date of Test	Section	Station	Distance from Lt/Rt Edge (ft)	Average Test Site Density Wet (pcf)	Average Test Site Density Dry (pcf)	Method	Percent Moisture
3/29/95	320201	5+40	5' from outside shoulder	116.6	105.5	B	10.6
5/2/95	320204	5+40	5' from outside shoulder	116	98.8	B	17.3
4/10/95	320205	0-40	5' from outside shoulder	119.9	102.8	B	16.6
5/4/95	320206	5+40	4' from outside shoulder	116.9	98	B	19.2
5/2/95	320207	5+40	7' from outside shoulder	122.1	105.2	B	16
5/3/95	320210	5+40	7' from outside shoulder	126.8	108.8	B	16.5
4/27/95	320211	5+75	7' from outside shoulder	124.9	103.4	B	20.7
5/12/95	320259	1+00	6' from outside shoulder	123.4	107.6	B	14.7
5/12/95	320259	2+50	6' from outside shoulder	122.6	106	B	15.6
5/12/95	320259	4+00	6' from outside shoulder	125.5	109.1	B	15.1
5/12/95	320259	5+35	6' from outside shoulder	123.4	107.4	B	14.9

Table 3. Borrow.

Section	Test No. from Figure A2	Average Test Site Density Dry (pcf)	% of Optimum Dry Denisty	% Moisture
320201	T8	126 1		6.5
320201	T9	132 2		6.6
320201	T10	127.6		6.9
320201	T11	127		6 8
320202	T40	130.5		6
320202	T41	131		5.9
320202	T42	133.2		5.4
320203	T19	129.7		6.2
320203	T20	126.5		7
320203	T21	123.5		5 4
320204	T29	128.9		6.3
320204	T30	128.7		6.1
320204	T31	129.2		5.8
320204	T32	127.5		5.6
320205	T4	130.2		4 8
320205	T5	130.9		4.7
320205	T6	130.9		5 7
320205	T7	133		4.8
320206	T43	132		5.7
320206	T44	127.3		6.2
320206	T45	128.2		4.5
320206	T46	126.9		4 9
320207	T22	132.3		4.9
320207	T23	137.4		3.4
320207	T24	131.6		5.4
320207	T25	130.2		6
320208	T26	129		4.9
320208	T27	129.8		5.7
320208	T28	132.1		6.7
320209	T12	134.3		6.2
320209	T13	131.5		7
320209	T14	136.6		6
320210	T36	127.2		5.7
320210	T37	126		6.7
320210	T38	128.3		6
320210	T39	127		7.2
320211	T15	123		4.9
320211	T16	125		5
320211	T17	128.9		5.3
320211	T18	124.9		6.2
320212	T33	128.9		6.1
320212	T34	130		6.7
320212	T35	131.1		7.4

Table 4. SPS-2 lime stabilized subgrade FWD averages and standard deviations at 4500 lbs, sensor 1.

Section	Midlane Average (mils)	Midlane Standard Deviation (mils)	Outer Wheelpath Average (mils)	Outer Wheelpath Standard Deviation (mils)
320201	40.6	26.0	62.4	44.0
320202	not tested		not tested	
320203	not tested		not tested	
320204	not tested		not tested	
320205	64.6	42.8	56.5	34.2
320206	not tested		not tested	
320207	not tested		not tested	
320208	not tested		not tested	
320209	68.9	39.0	43.4	20.9
320210	not tested		not tested	
320211	29.0	19 8	17.4	2.9
320212	not tested		not tested	

Table 5. SPS-2 embankment FWD averages and standard deviations at 4500 lbs, sensor 1.

Section	Midlane Average (mils)	Midlane Standard Deviation (mils)	Outer Wheelpath Average (mils)	Outer Wheelpath Standard Deviation (mils)
320201	43.5	32.2	61.8	40.5
320202	11.9	1.9	17.6	5 0
320203	18.5	2.7	16.9	6.8
320204	10 2	1.5	8.1	1.6
320205	43.1	35.8	47.8	36.2
320206	19.3	3.2	16.8	1.9
320207	32.1	18.3	18.9	2.8
320208	16.6	2.1	12.6	2.3
320209	42.5	37.4	25.3	14.1
320210	12.6	1.6	12.8	1.6
320211	13.4	2.2	13.0	2.1
320212	13.0	2.4	9.2	1.7

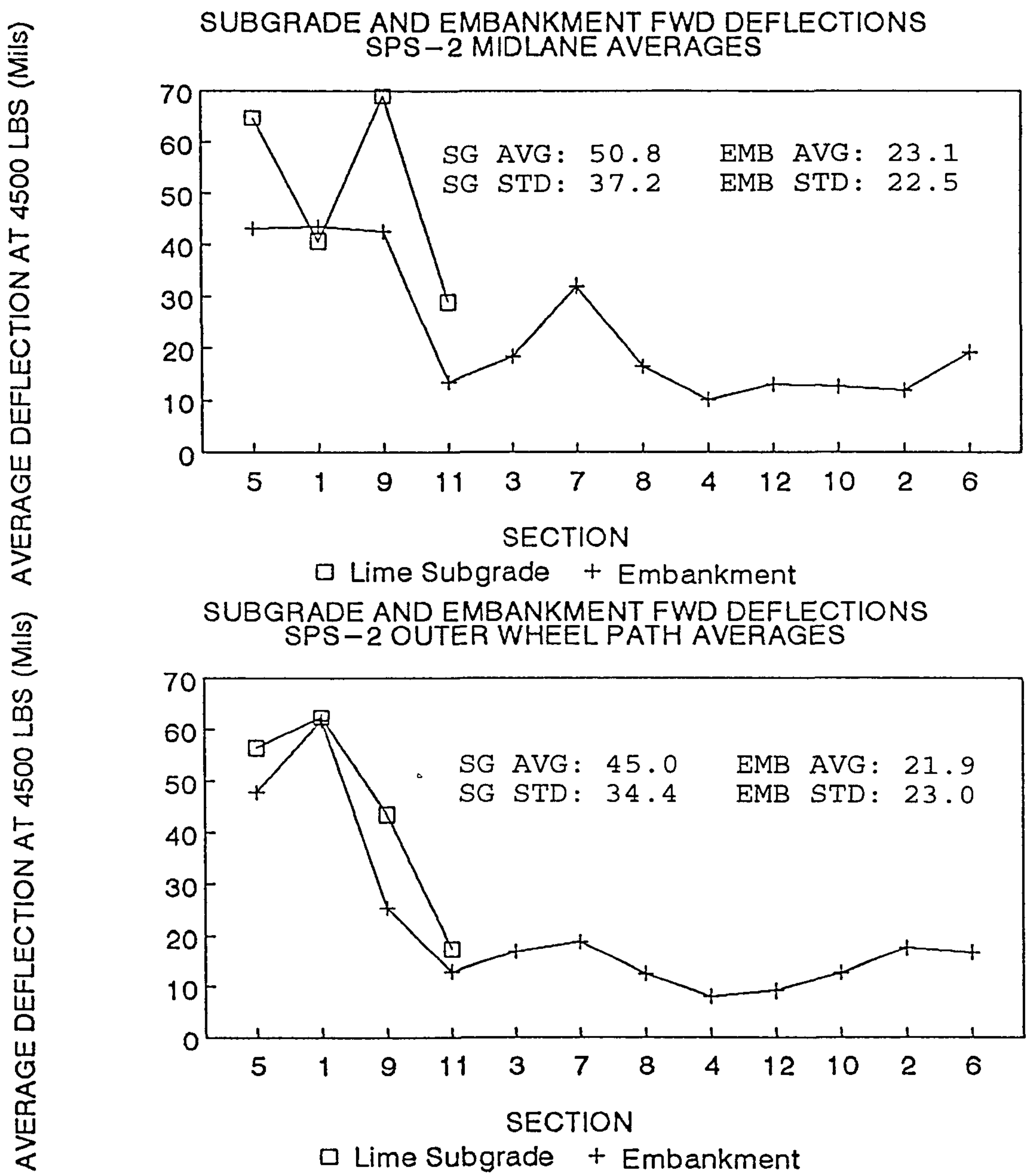


Figure 3. Subgrade and embankment average deflections, midlane and OWP, NV SPS-2.

Sections 320201, 320205, and 320209 had significantly higher deflections and standard deviations on both the subgrade and embankment than in the other sections. Section 320207 also had a high average deflection and standard deviation compared to the other embankment sections. The embankment deflections were relatively consistent throughout the project with the exception of the sections mentioned.

The SPS-2 embankment FWD deflections averaged 22.5 mils compared to a 13.6 mil average for the SPS-1 sections. By omitting sections 320201, 320205, and 320209, the SPS-2 deflections averaged 16.4 mils for the embankment.

Embankment Thicknesses

An elevation survey performed before and after the embankment was placed yielded the thicknesses in table 6.

DENSE GRADED AGGREGATE BASE (DGAB)

Six inches of DGAB were placed directly on the embankment in sections 320201, 320202, 320203, and 320204. Four inches of DGAB were placed directly on the embankment in sections 320209, 320210, 320211, and 320212.

Materials

The aggregate used for the DGAB was a crushed gravel, meeting the Nevada DOT Type 1, Class B specification. The gradation for the DGAB is shown in table 7.

The majority of the crushing operations took place at the Negro Pit (NDOT designation 83-6) where the rocks were crushed in two cones. Some crushing was also performed at pit 83-8.

Equipment and Construction Methods

Placement of the DGAB took place between June 21 and June 26-28, 1995. The types of equipment included in the operation were:

- 1 Gomaco B500-B trimmer
- 2 Catepillar 14G blades
- 1-2 water trucks
- 1 Catepillar CS-563 single drum vibratory roller
- 1 Bomag BW213 D-2 single drum vibratory roller
- 1 Catepillar 623B scraper
- 7 belly-dump trucks (2 singles, 2 "junior" doubles, 3 full doubles)

The belly dumps hauled DGAB (NDOT Type 1 Class B base) to the sections. The DGAB was dumped in windrows that were usually several truckloads thick before being graded. In "rough grading," the Catepillar 14G graders made 6 to 7 passes in both directions until the

Table 6. Embankment thicknesses.

Section	Average	Maximum	Minimum	Standard Deviation
320201	21.7	24.7	19.6	1.5
320202	22.7	24.2	20.8	0.8
320203	20.2	22.3	19.0	0.6
320204	20.5	22 4	18.7	1 0
320205	22.6	25.4	20.6	1.0
320206	23.5	24.8	22.7	0.5
320207	19.7	22.2	16.2	0.9
320208	20.4	22.8	19.4	0.8
320209	20.7	23.4	16.7	1.4
320210	21 3	22.6	20.0	0.5
320211	18.2	19.9	14.9	1.1
320212	18.8	20.8	17.9	0.6
320259	This layer does not exist for this section			

Table 7. DGAB gradation.

Sieve	% Passing
1-1/2	100
1	96
3/4	85
½	67
3/8	59
#4	46
#10	37
#40	24
#80	17
#200	12.4

base was spread out sufficiently to form a uniform mat about 2.5 in thicker than the target (compacted) thickness. The 4 in sections received one 4 in lift, the 8 in sections two 4 in lifts, and the 12 in sections two 6 in lifts. No automatic elevation control was used at this stage.

The rough graded mat was compacted in 6 to 7 passes of the Catepillar CS-563 single drum vibratory roller. After the primary compaction, the base was trimmed to 3/16 in above the target grade and recompacted utilizing a Bomag BW213 D-2 single drum vibratory roller. Trimming was accomplished utilizing either a Catepillar 146 grader with electronic controls with a guide on grade or a Gomaco B500-B trimmer. Water trucks sprayed water on the DGAB throughout the placement operations.

Quality Assurance Sampling and Testing

Bulk samples of the DGAB were taken and density tests performed as shown in figure A3, appendix A. Results of the density tests are given in table 8.

FWD Testing

FWD testing on the DGAB was performed on June 28th. The deflection plots are shown in appendix B. Table 9 lists the averages and standard deviations for both the midlane and outer wheelpath.

Sections 320201 and 320209 had high averages and standard deviations. The deflections in these two sections followed the same general pattern as the weak subgrade, as shown in appendix B. Section 320203 had high deflections in the first 125 ft of the section in the midlane, causing the average and standard deviation to be high.

DGAB Thicknesses

Table 10 gives DGAB thicknesses for each section measured by an elevation survey.

PERMEABLE ASPHALT TREATED BASE

Four of the twelve SPS-2 sections (320209, 320210, 320211, and 320212) received a 4 in permeable asphalt treated base (PATB). The PATB was placed over 4 in of DGAB in all four sections. Transverse interceptor drains and longitudinal drains were placed in all of the sections, prior to PATB placement. PATB paving took place on July 10th and 11th.

Equipment and Construction Methods

The equipment used in the PATB placement included the following:

- Catepillar AP-1050 paver
- Catepillar Extend-A-Mat 10-20B screed
- Catepillar CB-534 double-drum vibratory roller (13 tons)

Table 8. DGAB.

Section	Test No. from Figure A3	Average Test Site Density Dry (pcf)	% of Optimum Dry Density	% Moisture
320201	T54	139.2		6.3
320201	T55	136.6		6.4
320201	T56	130.9		5.2
320201	T57	126.8		5.5
320202	T76	135.8		5.2
320202	T77	135.2		6
320202	T78	133.4		6.1
320203	T62	139.3		6
320203	T63	137.1		5
320203	T64	135.8		5.8
320204	T65	135.8		5.6
320204	T66	137.4		5.6
320204	T67	138.4		5.9
320204	T68	138.3		6
320209	T55	136.2		5
320209	T56	135.5		6 1
320209	T57	130.9		5.4
320210	T72	1334.4		5.7
320210	T73	128.1		5.6
320210	T74	127.4		6
320210	T75	129 6		5
320211	T58	136		5.6
320211	T59	138.2		5.1
320211	T60	137.6		4.7
320211	T61	133.9		6
320212	T69	133.4		4.9
320212	T70	138.6		6.2
320212	T71	135.8		5.2

Table 9. SPS-2 DGAB FWD averages and standard deviations at 9000 lbs, sensor 1.

Section	Thickness (inch)	Midlane Average (mils)	Midlane Standard Deviation (mils)	Outer Wheelpath Average (mils)	Outer Wheelpath Standard Deviation (mils)
320101	6	45.4	21.7	44.3	21.7
320102	6	35.1	7.8	25.7	2.7
320103	6	42 4	26.2	23.3	2.7
320104	6	36.4	3.5	23.1	4.6
320109	4	36.7	19.9	29.4	18.8
320110	4	44.2	9.5	25.5	1.6
320211	4	23.5	1.8	22.1	1.5
320112	4	27.1	5.6	22.0	2.6

Table 10. DGAB thicknesses.

Section	Average	Maximum	Minimum	Standard Deviation
320201	5.9	7.0	4.6	0.6
320202	5.8	6.7	5.2	0.4
320203	5.7	6 7	4.3	0.4
320204	6.2	6.7	5.6	0.2
320205	This layer does not exist for this section			
320206	This layer does not exist for this section			
320207	This layer does not exist for this section			
320208	This layer does not exist for this section			
320209	4.2	5.0	3.4	0.3
320210	4.2	4.7	3.6	0.2
320211	4.0	4.8	3.2	0.3
320212	4.2	4.6	3.4	0.2
320259	This layer does not exist for this section			

- Ford 545A front end loader
- Oil truck for liquid asphalt
- 7 belly dump trucks

The operation began with the priming of the sections to be paved with MC-250 liquid asphalt. The MC-250 was then dusted with a fine coat of sand to prevent tracking by construction traffic. The specifications for the MC-250 are given in appendix C. When paving the SPS-2 sections, the PATB material was loaded directly into the paver's hopper using end-dump trucks. Six end-dump trucks were used.

Asphalt Plant

The asphalt plant was located approximately 5 miles from the project in pit 83-8. It was a CMI drum plant purchased in 1994 and belonged to Honeywell in Winnemucca. The plant could produce a maximum of 375 tons per hour. The asphalt cement was refined at Huntway Refining Company from Benicia, California. The refinery produced the AC-20, AC-20P, and AC-30 grades of binder that were used on the project.

Edge Drain Construction

Trenching for the edge drains began on June 29th and continued through July 5th. The trench line was marked with spray paint and a stringline. The trencher followed the line, and depths were checked every 12 ft.

A construction fabric was laid in the trench and fastened so that it would not fold under the pavement. The fabric extended about 4 ft onto the outer edge of the roadway and about 3 ft from the outer edge of the trench. Also, about 4 ft of fabric was rolled out on the inside edge of the DGAB and would later be folded over the PATB to prevent fines from contaminating the PATB from the inside edge.

An open graded rock was then placed into the trench about 3 in thick. A 4 ft diameter Cresline SCH40 Nema TC-2 Rigid PVC slotted pipe was placed over the rock and more rock was placed to cover the pipe.

Transverse interceptor drains were placed at the following stations: 1631+95, 21+90, and 29+10.

Edge drain outlets were placed at the following stations: 1620+40, 1622+90, 1625+45, 1628+00, 1630+55, 11+45, 14+00, 16+50, 17+25, 20+05, 24+05, and 26+55.

PATB Paving

On July 10th, the PATB in sections 320209 and 320211 was paved in three continuous passes. The outer pass was 12 ft wide, the middle pass was 15 ft wide, and the inner pass was 13 ft wide.

Also on July 10th, parts of sections 320210 and 320212 were paved: the inner pass in both sections, and from the beginning of section 320212 to station 9+80 on the outer and middle passes. The outer pass was 13 ft wide, the middle pass 14 ft wide, and the inner pass 13 ft wide.

On the inner and outer passes, the paver elevation was controlled by the wireline on both sides of the roadway. On the middle pass, the elevation was controlled by the joint matching shoe heights of the adjacent passes. No ski was used. The paver steered along a paint line marked out with stringline.

On July 11th, paving was finished in sections 320210 and 302012. The plant broke down for three hours just before starting the middle pass. Two single end-dump trucks waited the entire three hours with full loads, and the loads were used for paving.

Table 11 lists the PATB mix temperatures at the plant and paver during production. Table 12 lists the temperature and weather during paving.

Table 11. PATB mix temperatures at the plant and paver during production, NV SPS-2.

Date	Average PATB Plant Temperature (°F)	Standard Deviation (°F)	Average PATB Paver Temperature (°F)	Standard Deviation (°F)
07/10/95	289	9.8	283	5.2
07/11/95	279	4.2	278	2.7

Table 12. Temperatures and weather during PATB paving, NV SPS-2.

Date	Sections Paved	Low Temperature (°F)	High Temperature (°F)	Type of Weather
07/10/95	320209, 320210, 320211, 320212	61	94	Scattered clouds, hot & windy at times
07/11/95	320210, 320212	53	86	Scattered clouds & hot

Compaction

The mat was rolled after it had cooled to 170°F, about two hours after laydown. As with the SPS-1 sections, two complete coverages were made on each pass. For each width of PATB placed, the compactor made two passes in three overlapping widths, (i.e., covering the outer, middle, and inner surface).

Quality Assurance Sampling and Testing

Samples of the PATB were taken at the locations shown in figure A4, appendix A.

Loose Paving Thicknesses and Final Compacted Layer Thicknesses

Loose lift thicknesses were measured during paving and are given in table 13. An elevation survey was used to determine the final compacted layer thicknesses, shown in table 14.

Table 13. Loose lift thicknesses, PATB paving, NV SPS-2.

Section	Lift	Average Loose Lift Thickness (inch)	Standard Deviation (inch)	Low Thickness (inch)	High Thickness (inch)
320209	1	4.1	0.3	3.4	4.8
320210	1	4.0	0.2	3.5	4.3
320211	1	4.1	0.6	2.9	5.6
320212	1	4.2	0.4	3.0	4.9

Table 14. Final lift thicknesses, PATB layer, NV SPS-2.

Section	Average Thickness (inch)	Standard Deviation (inch)	Low Thickness (inch)	High Thickness (inch)
320209				
320210				
320211				
320212				

Detailed Construction

Section 320209

Paving began in the outer pass going eastbound on July 10th at 8:00 a.m. Paving in the middle pass began around 10:30 a.m., and the inner pass at 1:30 p.m. Each pass took about one hour to complete.

The average loose paving thickness was 4.1 in, with a 0.4 in standard deviation. The average compacted thickness was 4.0 in, with a standard deviation of 0.4 in. The average temperature of the mix at laydown was 272°F.

Section 320210

This section was paved on July 11th. The outer pass was paved from 8:00 a.m. to 8:55 a.m., the middle pass from 1:30 p.m. to 2:20 p.m., and the inner pass from 3:30 p.m. to 4:15 p.m.

The average loose paving thickness was 4.1 in, with a 0.2 in standard deviation. The average compacted thickness was 3.7 in, with a standard deviation of 0.2 in. The average temperature of the mix at laydown was 275°F.

Section 320211

This section was paved on July 11th. Paving in the outer pass began at 9:00 a.m., in the inner pass at 12:00 p.m., and the middle pass at 3:00 p.m. Each pass took about one hour to complete.

The average loose paving thickness was 4.1 in, with a 0.6 in standard deviation. The average compacted thickness was 4.1 in, with a standard deviation of 0.5 in. The average temperature of the mix at laydown was 292°F.

Section 320212

Paving up to station 9+25 going eastbound was completed on July 10th in the middle and outer passes. On July 11th, the outer pass was paved from 6:30 a.m. to 8:00 a.m. Following this pass, the plant broke down for three hours, and the middle pass was not started until 12:00 p.m., finishing at 1:20 p.m. The inner pass was paved from 1:45 p.m. to 3:30 p.m.

The average loose paving thickness was 4.3 in, with a 0.3 in standard deviation. The average compacted thickness was 4.1 in, with a standard deviation of 0.3 in. The average temperature of the mix at laydown was 285°F.

LEAN CONCRETE BASE

Four of the twelve SPS-2 sections received a 6 in lean concrete base (LCB). The LCB was placed directly on the embankment in all four sections. Paving began on July 6th and was completed on July 8th.

Materials

The mix design used for the lean concrete base is summarized in table 15. The complete mix design for the LCB is given in appendix D. The gradation used for the LCB aggregates is given in appendix E.

Table 15. Lean concrete base mix design summary.

	Quantities for 1.0 Cubic Yards of Concrete
Cement type:	Nevada Type II - Low Alkali
Cement (sacks/yard):	2.1
No. 67 Coarse Aggregate (lbs):	1,663
Crushed Fines (lbs):	810
Natural Fines (lbs):	803
Water Reducer (oz):	none
Water Cement Ratio:	1.23
Slump (inch):	1.25
Air Content (%):	4.3
Design Compressive Strength (psi):	500 +/- 50 @ 7 days

Equipment and Construction Methods

The LCB/PCC mixer was a 12 yd^3 double drum type with a 60 second mix time. The concrete was close to 85°F coming out of the plant that was located approximately 1 mile from the project in pit 83-6. The plant was an In Line Double Drum Rex purchased in 1987. The drums held 12 yards of mix, and there was a 55 second mix time.

The equipment used in the LCB placement included the following:

- Guntert and Zimmerman S1000 Paver
- Curing Compound Bridge
- Catepillar 950E Loader
- Water truck
- Seven single belly dump trucks
- Four end dump trucks

The LCB mix was hauled to the site in single belly dump trucks. The trucks entered the grade at turn-ins which were spaced at approximately 400 ft intervals. The trucks then backed up to the paver and dumped their loads. The Catepillar loader then pushed the mix into the paver vibrators.

The paver had elevation controls and lateral alignment controls at the front and rear on each side of the paver, which ran off the wire line. The LCB was placed 40 ft wide in one pass for all sections. No joints were sawed in the LCB.

Finishing was accomplished with a screed, followed by an automatic zig-zag float assembly, followed by a burlap drag. When necessary, hand floats were used to provide additional finishing. Approximately an hour following paving, a curing compound was applied by a bridge assembly. The curing compound brand was:

- WR Meadows Seal Tight 1600
- White ASTM C-309 Type II Class A

The application rate was approximately 1 gal/200 ft^2.

Quality Assurance Sampling and Testing

Samples of the LCB were taken at the locations shown in figure A4, appendix a. Six cylinders were formed at each location and slump and air tests were performed. Table 16 lists the results of the slump and air tests.

Table 16. LCB slump and air.

Section	Air Voids (%)	Slump (in)
320205	7.5	1.8
320206	5.7	2.0
320207	6.5	2.0
320208	6.5	2.0

LCB Thickness

Table 17 lists the average thicknesses for each section obtained by an elevation survey before and after construction.

Table 17. LCB thicknesses, NV SPS-2.

Section	Average Thickness (inch)	Standard Deviation (inch)	Low Thickness (inch)	High Thickness (inch)
320205	7.2	0.67	6.4	7.8
320206	6 6	0 23	6.2	6.8
320207	6.9	0.10	6.7	7.0
320208	7.5	0.61	6.8	8.4

Detailed Construction

Section 320205

Paving at the beginning of the monitoring sections began at 9:45 a.m. on July 6 at station 0+00. The paver stopped at station 0+50 at 9:50 a.m., and started again at 10:05 a.m. Five trucks were waiting in line from 9:45 a.m. until 10:05 a.m. From station 1+10, there were a lot of cracks 6 ft to 7 ft in from the median that were finished by hand. The inner edge was extremely rough for about 20 ft. Water was hand sprayed on the small cracks and rough area to aid in finishing. From station 1+70 to 1+80, there was heavy cracking all the way across the LCB. Water was used heavily in this area to aid in finishing.

At 10:40 a.m., a curing compound was applied to the LCB. Two passes were made. At stations 2+50, 3+05, 4+10 and 4+85, the paver stopped for 5 to 10 minutes. Paving in the monitoring sections was completed at 11:30 a.m. The paver was hosed off with water following paving of this section.

On July 17th, just prior to paving the PCC, the LCB showed extensive shrinkage cracking throughout.

Section 320206

Paving was completed on July 8th going from east to west. Paving started at station 5+95 at 6:45 a.m. Paving in the 500 ft monitoring section at station 4+40 began at approximately 7:30 a.m. The paver stopped for 10 minutes at station 2+90.

At 7:51 a.m., the curing compound was applied to the east end of the section. Two passes at approximately 150 ft per pass were made. The paver stopped for 15 minutes at station 1+05 and for 10 minutes at station 0+05. At station -1-20, 60 ft past the monitoring section, the paver stopped for 16 minutes. Paving in the 500 ft monitoring section was completed at approximately 8:45 a.m. No significant finishing problems were encountered during paving of this section.

Section 320207

On July 6th, paving started at 2:10 p.m. at station 0+95. The LCB was placed on the grade at 2:10 p.m. and the paver did not vibrate the mix until 2:25 p.m. At station 0-15 at 2:40 p.m. the contractor realized that the LCB was 3 in too high. At 3:10 p.m. all of the LCB that had been paved was removed by front end loaders. At 3:50 p.m. after cleaning up the grade, operations were shut down for the day.

On July 7th, 1995 paving began again at 6:40 a.m. Five belly dump trucks and four end dump trucks were used to place the LCB. A load of LCB was placed on the grade approximately every 90 seconds.

Water was sprayed moderately throughout the section after screeding and before finishing. There were several stops of 5 to 10 minutes throughout the section at stations 0+00, 0+70, 1+90, 2+70 and 6+96.

Curing was started at 8:10 a.m. Two passes at 300 ft per pass were performed. Paving in the monitoring sections was completed at 8:45 a.m. No significant finishing problems were encountered during paving.

On July 17th, random block cracking was present every 15-20 ft within 16 ft of the inner edge.

Section 320208

Paving began July 7th in the monitoring section at station 0+65 at 9:00 a.m. Brush brooms and hand floats were used for finishing, prior to the burlap drag. During paving of this section, the paver moved at approximately 7 ft per minute. Paving in the monitoring section was finished at 10:15 a.m.

On July 17th, prior to PCC paving, random cracking was present in the LCB every 15-20 ft within 16 ft of the inner edge.

PORTLAND CEMENT CONCRETE

The 12 SHRP SPS-2 sections received a PCC surface layer. The thicknesses, travel lane widths, and design flexural strengths varied by section, as was shown in figure 2. State section 320259 received a 10.5 in PCC surface layer. The width of the travel lane was 12 ft, and the design compressive strength was 4000 psi plus or minus 20 percent at 14 days. Paving began on July 14th in section 320259, and going eastbound was completed on July 31st in section 320206. Section 320212 had severe cracking problems, and most of the section was torn up and removed. The section was repaved on August 16th using the state standard mix design.

Materials

Three different concrete mixes were used for the 13 test sections as follows in Table 18.

Table 18. PCC mixes, NV SPS-2.

Section	Mix Design 14-Day Average Compressive/Flexural Strength (psi)	Specified 14-Day Design Strength (psi)
320259	4,530 (compressive)	4000+/-20%*
320201, 320203, 320205, 320207, 320209, 320211	451 (flexural)	475*
320202,320204, 320206, 320208, 320210, 320212	745 (flexural)	750*

*See mix design in following section

Three types of aggregate were used for the PCC mixes:

- #4 coarse, NDOT Dept. 83-06
- #67 coarse, NDOT Dept. 83-06
- #67 fines, Silver State Pit

The state mix and SHRP 475 psi mix contained 38 percent fine aggregate and 62 percent course aggregate. The SHRP 750 psi mix contained 40 percent fine aggregate and 60 percent course aggregate.

Gradations of the aggregate taken during production are given in table 19 and 20. Appendix E gives the target gradations used in the mix designs for all three mixes.

Additives

Two additives were used during the mix design procedure as follows:

1. Paver Air 90 - an air entraining admixture meeting AASHTO M154 specifications. The manufacturer was Master Builders, Inc. of Cleveland, Ohio.

2. Master Pave - A Type-A water reducing agent, meeting AASHTO M194 specifications. The manufacturer was Master Builders, Inc. of Cleveland, Ohio.

Table 19. PCC gradations (475 psi mix).

														PCC Gradations (475 psi mix) and State Mix	
	Date	7/17/95	7/17/95	7/17/95	7/18/95	7/18/95	7/20/95	7/20/95	7/20/95	7/21/95	7/21/95	7/21/95	7/21/95		
	Test No.	T-1-31	T-2-31	T-3-31	T-1-32	T-2-32	T-1-33	T-2-33	T-3-33	T-1-34	T-2-34	T-3-34	T-4-34		
Sieve	Specs	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	Mean	StDev
2	100	100 0	100 0	100.0	100.0	100	100 0	100 0	100 0	100.0	100	100 0	100 0	100 0	0.0
1-1/2	90-100	98.6	99.2	98.7	98.2	98.7	97 1	95.3	98 2	97.4	96.8	94.5	98.2	97.6	1.4
1	50-86	84.4	94.0	84.5	84.8	92 7	78.1	81.5	94.9	82.2	90.6	79.8	84 2	83.5	3.1
3/4	45-75	72.2	72.7	73.6	74.7	73.6	71 9	72.5	75.3	71.7	71.7	72.1	73 2	72.9	1 2
3/8	38-55	48.5	50.0	50.9	81.6	49 6	50 6	50.0	52.3	49 3	50.8	53.3	54.0	53 4	9 0
#4	30-44	40.7	41.2	41.3	41.3	40.6	41 8	40 8	41 4	41.8	42.0	42.6	43.2	41.6	0.8
#8	23-38	32.3	33.1	32.8	33.0	32 7	34 2	32.8	33.1	34.6	34.0	34 7	35 1	33.5	0.9
#16	15-33	21.6	23.0	22 3	22.7	23 0	24 7	23.6	23.0	24.4	23.7	24.4	25 2	232.5	1.1
#30	8-22	12.9	14.0	13.5	13.2	13.2	15 4	14.4	13.7	14.6	14.1	15.2	16 1	14.2	1.0
#50	4-13	4.7	5.0	4.8	5.1	5 1	6.4	5 6	5.3	5 4	5.3	5.5	6.2	5.4	0.5
#100	1-15	2 1	2.2	2.1	2.3	.2	2.4	2 1	2.2	1.9	2.0	1.9	2.2	2.1	0.1
#200	0-3	1.5	1.6	1.5	1.7	1.7	1.6	1.4	1.5	1.3	1.5	1 3	1.5	1.5	0.1

Table 20. PCC gradations (750 psi mix).

PCC Gradations (475 psi mix) and State Mix													
	Date	7/24/95	7/24/95	7/25/95	7/25/95	7/28/95	7/28/95	7/28/95	7/31/95	7/31/95	7/31/95		
	Test No.	T-1-35	T-2-35	T-3-36	T-1-36	T-2-37	T-1-37	T-2-37	T-3-38	T-1-38	T-2-38		
Sieve	Specs	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	% Passing	Mean	StDev
1	100	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0
3/4	80-100	95.9	98.1	97.4	98.6	94.6	95.6	97.4	98.7	96.2	95.6	96.8	1.4
3/8	46-70	62.3	63.1	64.0	63.8	56.6	61.4	62.1	61.3	62.1	61.1	61.8	2.1
#4	34-50	44.3	44.1	44.3	44.1	42.7	43.2	43.4	43.9	43.1	43.8	43.7	0.6
#8	24-42	35.3	35.0	35.6	34.9	34.6	35.1	35.4	35.1	34.3	35.5	35.1	0.4
#16	17-34	24.9	24.7	24.5	25.1	24.9	24.7	24.8	24.9	23.7	25.1	24.7	0.4
#30	10-25	15.8	15.5	14.8	15.7	15.5	15.9	15.7	16.0	14.5	16.0	15.5	0.5
#50	5-15	5.9	5.9	5.8	6.1	6.1	6.2	5.8	6.8	5.2	6.1	6.0	0.4
#100	2-7	2.3	2.2	2.5	2.3	2.1	2.3	2.1	3.2	1.7	2.2	2.3	0.4
#200	0-3	1.7	1.5	1.9	1.7	1.4	1.7	1.4	2.4	1.2	1.5	1.6	0.3

Cement

A fly ash cement was used for all three PCC mixes met Nevada DOT Type 1P specifications. The manufacturer was Nevada Cement of Fernley, Nevada.

Mix Designs

The initial SHRP SPS-2 target 14-day flexural design strengths were 550 psi and 900 psi. The contractor initially performed several trial mixture designs using the local aggregate. The typical mixture design strengths for the lower strength mixture showed that average strengths in the range of 500 psi could be achieved. The typical strength of the 900 psi mixes was close to 750 psi.

Due to these lower than specified strengths, additional trial mixtures for the 900 psi mix were performed using aggregate from a source near Reno, Nevada. The strength values for one mixture averaged 810 psi, at 14 days.

Due to the difficulty of achieving the 900 psi design strength with the local aggregate, the LTPP technical assistance contract, PCS/LAW, was consulted. The final decision was that strength differences between the low and high strength mixes of at least 200 psi, preferably more, would be acceptable for the experiment. The target 14-day flexural design strengths were therefore changed to 475 psi and 750 psi, a difference of 275 psi. The local aggregate source was used for the mixes.

Tables 21, 22, and 23 summarize the mix designs used for the state 4000 psi mix, and the SHRP 475 psi and 750 psi mixes, respectively. Appendix D shows the mix design for the state mix, and the SHRP 475 psi and 750 psi mixes, respectively.

Equipment and Construction Methods

The equipment and construction methods used for the PCC paving were similar to the LCB paving, with the addition of the following equipment:

- CMI SP-400 Dowel Bar/Tie Bar Inserter
- Tining Bridge
- Water Bridge
- Clary finish attached to the screed plate

The PCC was placed 38 ft wide in one pass for all sections and thicknesses.

The belly dump trucks and end dump trucks backed up to the dowel bar/tie bar inserter (DBI) to dump their loads. The front end loader then pushed the PCC mix into the auger of the dowel bar inserter. As with the paver, the dowel bar inserter had elevation controls and lateral alignment controls at the front and rear on both sides.

Table 21. State 4000 psi mix design summary.

	Quantities for 1.0 Cubic Yards of Concrete
Cement Type:	Nevada Type 1P
Cement (Sacks/Yard):	6.5
No. 4 Coarse Aggregate (lbs):	866
No. 67 Coarse Aggregate (lbs):	984
No. 67 Fine Aggregate (lbs):	1,097
Water Reducer (oz):	2.0 oz/100 lbs cement
Water Cement Ratio:	0.41
Slump (inch):	1.5
Air Content (%):	4.4
Design Compressive Strength (psi):	4000 +/- 20% @ 14 days

Table 22. SHRP 475 psi mix design summary.

	Quantities for 1.0 Cubic Yards of Concrete
Cement Type	Nevada Type 1P
Cement (Sacks/Yard):	4.5
No 4 Coarse Aggregate (lbs)	946
No. 67 Coarse Aggregate (lbs).	1078
No. 67 Fine Aggregate (lbs).	1,198
Water Reducer (oz)·	2.0 oz/100 lbs cement
Water Cement Ratio:	0.49
Slump (inch):	1.3
Air Content (%)·	5.2
Design Compressive Strength (psi):	475 psi @ 14 days

Table 23. SHRP 750 psi mix design summary.

	Quantities for 1.0 Cubic Yards of Concrete
Cement Type.	Nevada Type 1P
Cement (Sacks/Yard)·	9.0
No. 67 Coarse Aggregate (lbs):	1,640
No. 67 Fine Aggregate (lbs):	1,055
Water Reducer (oz):	3.0 oz/100 lbs cement
Water Cement Ratio:	0.32
Slump (inch):	1.5
Air Content (%):	4.0
Design Compressive Strength (psi):	750 psi @ 14 days

After going through the auger, a strikeoff leveled the PCC. Following the strikeoff, the PCC mix was vibrated with vibrators spaced 15 in apart. At this point, the PCC was considered fully consolidated. Following the vibration, a strikeoff again leveled the PCC mix.

Following the strikeoff, greased epoxy coated dowels were placed at the joints on the surface of the PCC mix by the DBI. The joints were marked by steel pins on the edge of the roadway, and a computer on the DBI then located each steel pin. After placing the dowels, the DBI moved ahead 1 ft to 1.5 ft and stopped over the dowels. Forked arms on the DBI then pushed the dowels into the PCC mix. A horizontal rotary vibrator was connected to the frame of the forks with rubber washers transmitting vibration to each fork. The vibration frequency was about 5000 - 6000 vpm's. The forks pushed the dowels into the PCC, stopped for 1 second at the bottom of the cycle, then were lifted out. Vibration occurred during the entire cycle. The greased epoxy coated dowels were spaced 1 ft apart transversely at 15 ft intervals longitudinally. The dowel bars were 1-1/4 in diameter for the 8 in thick PCC and 1-1/2 in diameter for the 11 in thick PCC. All dowels were 18 in long.

Tie bars were placed at centerline in all sections. The tie bars were manually placed in the tie bar inserter at 30 in longitudinal intervals, and the machine automatically inserted them.

The tie bars were #4, 30 in in length and inserted at 30 in intervals longitudinally between lanes in the SHRP sections. In two sections, 320212 and 320259, the tie bars were inserted at 2 ft intervals both between lanes and also at the lane/shoulder joint.

The paver followed the DBI about 30 ft behind. A horizontal vibration bar was located 3 in to 4 in above the surface of the PCC. The vibration frequency was 3000 vpm's. A head of PCC built up in front of the paver, and the horizontal vibration bar vibrated this mix into the longitudinal grooves left by the DBI. The horizontal vibration did not vibrate the previously vibrated PCC mix, thus once the dowels were placed, they were considered to be permanent.

Behind the paver a clary finisher was attached to the screed plate. Following the screed, a zig-zag float assembly was used followed by a burlap drag. On the 750 psi PCC sections a second burlap finish was applied just before tining. Also, a watering bridge was used just prior to tining. The tining was applied laterally by a tining bridge with no overlap. Approximately an hour following paving, a curing compound was applied by a spraying bridge assembly. The curing compound was applied in two directions, at 25 ft per pass. The application rate was approximately 200 ft^2/gal.

For all of the mixes, the concrete was watered down periodically on grade before and after paving, especially after sitting on grade with the paver stopped. The grade was also watered down prior to placing the PCC.

Sawing

Approximately ten hours following paving, the joints were sawed. The transverse joints had two cuts, the first with a 14 in x 0.125 in blade followed with a 16 in x 0.155 in blade. The longitudinal joint had one cut with a 16 in x 0.155 in blade. The longitudinal cut between the SHRP lane and shoulder was full depth, using a 24 in diameter blade followed by a 30 in diameter blade.

Sealing

Approximately 7 to 10 days following paving, the joints were sealed with a low modulus silicone material. A foam cord was rolled approximately 1-1/2 to 2 in deep in the joints. The sealant was then applied, in some joints all the way to the surface, and in other joints ½ in to 5/8 in below the surface. The depth of the sealant varied at every joint.

Quality Assurance Sampling and Testing

Figure A5 in appendix A shows the locations of bulk sampling and coring performed in the PCC sections.

PCC Thicknesses

Table 24 lists average thicknesses obtained in each section by an elevation survey before and after construction.

Profile Testing

Table 25 lists results of profile testing performed on each section.

Detailed Construction

Table 26 lists the temperature, humidity, windspeed, and solar radiation during the PCC construction. The data was obtained from a weather station located across the roadway from the test sections. Construction by test section will be discussed in the following section.

Section 320201

Paving began July 18, 1995, at approximately 7:00 a.m. All trucks, including full belly-dump trucks were driving on the SHRP lane PATB to deliver the PCC to this section. The trucks were not making any turns on the PATB, therefore didn't cause any damage.

From station 1+40 to station 3+00, the mat was rough 6 to 8 in in from the inner edge. This area was hand finished following the paver. Throughout the section, the inner side of the mat was rough in spots and hand finished. Paving in the sampling area was completed at approximately 9:30 a.m.

Table 24. PCC thickness, NV SPS-2.

Section	Average Thickness (in)	Standard Deviation (in)	Low Thickness (in)	High Thickness (in)
320201	9.2	1.1	6.8	12.8
320202	8.2	0.3	7.3	8.9
320203	11.6	0.4	10.9	12.1
320204	11.2	0 3	10.6	11.9
320205	8.3	0.3	7.4	8.8
320206	8.0	0.1	7.7	8.2
320207	10.3	0.2	9.8	10.9
320208	11.1	0.2	10.8	11.8
320209	8.0	0.4	7.1	9.2
320210	8.3	0.2	7.8	8.6
320211	10.8	0.7	9.6	12.8
320212	10.7	0.7	5.9	11.4
320259	12 7	0.4	11.6	13.6

Table 25. Average profile indices, NV SPS-2.

Section	Average Profile Index
320201	56.68
320202	97.69
320203	52.81
320204	98.71
320205	59.87
320206	89.65
320207	64.37
320208	106.20
320209	52.92
320210	72.40
320211	49 56
320212	73.98
320259	65.63

Table 26. PCC construction weather data.

Date	Sections Paved in Order	Time	Avg. Temperature (°F)	Mean Windspeed (ft/sec)	Min. Relative Humidity (%)	Max. Relative Humidity (%)	Avg. Solar Radiation (watts/ft^2)
7/14	320259	12:00 pm	68.1	6.3	22.3	29.8	87.5
		2:00 pm	72.7	7.8	18.3	22.4	92.2
7/17	320205	12:00 pm	86 7	5.2	15.8	19.1	86.5
		3:00 pm	93.6	13.7	8.2	9.8	86.5
7/18	320201,320209	7:00 am	66.6	3.1	32.8	39.3	11.9
		12:00 pm	90.3	6.8	11.9	14.4	83.9
7/20	320211,320203	8:00 am	67.3	2.2	52.4	62.8	28.4
		12:00 pm	82.8	6.7	25.2	29.0	85.9
		4:00 pm	87.4	8.8	14.3	17.6	52.8
7/21	320207,320208	8:00 am	68.4	5.8	39.2	49.5	28.1
		12:00 pm	84.4	6.9	18.8	24.9	85.3
		4:00 pm	91.2	6.8	12.7	14.7	69.4
7/24	320204	5:00 am	51.4	4.1	48.6	64.6	0
		10:00 pm	72.5	4.0	26.9	35.5	62.7
7/25	320212	5:00 am	49.6	6.4	32.6	39.8	0
		12:00 pm	84.4	7.0	8.7	13.2	87.9
7/28	320210,320202	7:00 pm	61.7	6.9	8.8	12.0	10.7
		1:00 am	93.4	10.6	5.4	8.0	91.1
7/31	320206	NO DATA AVAILABLE					
8/12	320212 (repaving)	NO DATA AVAILABLE					

Following paving, shrinkage cracks in the PCC were present at the following locations:

- station 2+75, passing lane
- station 3+00 to 3+35, passing lane
- station 3+50 to 3+95, passing lane
- station 4+10 to 4+70, passing lane
- station 4+85 to 5+45, passing and travel lanes.

Section 320202

Paving took place the evening of July 28, 1995, starting at close to 10:00 p.m. The following stops occurred during paving:

- station 1+45 for 10 minutes
- station 1+99 for 10 minutes
- station 2+70 for 4 minutes
- station 4+08 for 15 minutes
- station 4+60 for 7 minutes.

At station 1+90 at 11:25 p.m., the DBI had problems and was moving again at 11:40 p.m. The DBI left a transverse groove where it stopped, which was about 5 in deep and 7 in wide on the outer edge. On the inner edge the groove was negligible.

A construction joint was placed at station 12+60 (in transition between 320202 and 320206). There were severe shrinkage cracks in the last 300 ft of paving. These cracks fell out of the monitoring and sampling area. Paving was completed at close to 1:00 a.m.

Section 320203

Paving began on July 20, 1995, at approximately 1:00 p.m. The concrete in front of the paver was being watered frequently, by hand and by truck, in an effort to make the surface smoother prior to the paver passing over it. No significant problems were noted during the paving of this section.

During PCC hauling, trucks drove over the passing lane LCB in section 320207. Paving at the end of the monitoring section ended at approximately 3:45. A cold joint was placed at station 8+82 (in transition between 820203 and 820207).

The 3/4 in aggregate was reduced 2 percent, and the fine aggregate increased 2 percent from earlier paving on July 18, 1995.

Following paving, shrinkage cracks were present at the following locations:

- station 0-60
- station 1+25

- station 3+22
- station 3+45
- station 3+69

On July 21, 1995, from station 5+10 to the cold joint, many shrinkage cracks were present.

Section 320204

Paving began early on July 24, 1995, at 5:00 a.m., near the beginning of the sampling area. The paving train stopped for 24 minutes at station 0-58.

Up to station 0+30, there were 3 in to 5 in wide gaps left by the forks on the DBI. From station 0+15 to station 0+60 there were some deep cracks evident in the center of the mat that were filled in and finished by hand.

The following stops occurred during the remaining paving:

- station 0+35 for 6 minutes
- station 0+52 for 22 minutes
- station 0+55 for 19 minutes
- station 0+65 for 9 minutes
- station 1+25 for 5 minutes
- station 1+67 for 11 minutes
- station 2+75 for 4 minutes
- station 2+80 for 8 minutes
- station 3+25 for 3 minutes.

From station 1+00 to station 1+20, more gaps/cracks were evident after the DBI. Also there was cracking 6 to 8 ft from the outer edge up to station 1+50. From station 1+40 to 1+60, cracking was evident within 5 ft from the inner edge, and was filled in by hand and finished. At station 2+25, cracks behind the DBI were evident within 5 ft of both edges.

Section 320205

Paving began on July 17th at close to 12:00 p.m. Prior to starting this section, the paver slipped off of the elevation wire. A hump of approximately 20 in in depth and 20 ft long developed between stations -1-00 and 0-80. This was removed following placement along with the underlying LCB. This short section was paved by hand on August 15, 1995. The material was hauled by an end dump truck, dumped into a loader bucket, and poured into forms made from 2 in x 10 in boards. Dowels were preplaced on baskets. The finishing was done with a clary finisher followed by hand floats and a burlap drag. Texture was applied with hand tines and the curing compound was applied with a hose.

The transverse tie bars were pounded in by hand from the start of the section to station 2+90 due to an equipment failure.

There were stops of close to 5 minutes at stations 0+30, 0+40, 0+45, 0+95 and 1+15. The PCC mat was cracked and rough in the passing lane starting at station 0+40, and extending to station 1+15.

At station 1+20, for approximately 20 ft, the outside 10 ft of the mat was very rough and pitted, and was filled in and finished by hand.

At station 1+70, the contractor added water reducing agent to the mix up to the maximum of 4 percent. At station 2+90, the water/cement ratio was increased from 0.49 to 0.53.

From station 1+20 to station 2+60, shovelfuls of mix were thrown in front of the clary finisher on the inner edge, however, the finish was still a bit rough. At station 2+60, the inner edge began to get smoother. At Station 3+00, the entire mat was smooth without adding additional concrete in front of the clary. From station 5+00 to the end of the sampling area, there was some rough finish 6 to 8 ft from the inner edge, and this area was hand finished.

A cold joint was placed at station 5+90.

Ten days following paving, shrinkage cracks in the PCC were present at the following locations:

- station 0+25, passing lane
- station 1+15, travel lane
- station 1+45, travel lane
- station 1+75 to 4+15, both lanes and shoulders

Section 320206

Paving began in the transition area between sections 320202 and 320206 at 6:00 p.m. on July 31, 1995. The paving in the monitoring section began at 1:15 a.m.

The LCB was watered periodically at ½ hour intervals. During paving of the 2nd half of the section, the concrete in front of the DBI was watered down constantly. No significant stoppages or problems occurred while paving this section.

Section 320207

Paving was completed on July 21st. The LCB had random block cracking every 15 to 20 ft in the passing lane and outer shoulder, where the PCC trucks had been driving during earlier placement. The SHRP travel lane had a few scattered cracks, and the outer shoulder had very few cracks.

At this section, a second burlap drag was placed behind the water bridge. The LCB was watered approximately every ½ hour prior to PCC paving. The paver/DBI speed was approximately 6 ft/min during paving of this section.

There were stops of close to 10 minutes at station 6+32, 7+08, 7+60, and 7+75. Paving finished at close to 11:00 a.m.

Section 320208

Paving took place from 12:00 p.m. until 3:45 p.m. on July 21, 1995. This was the first section to be placed with a 750 psi mix. The mix change from section 320207 occurred at about station 0-87.

The PCC mix in front of the DBI was sprayed down almost continuously with water. There were stops of 5-10 minutes at stations 0-25, 0-12, 0+03, 0+15, 0+50, 0+67, 0+85, 0+92, and 3+01. There was a 29 minute stop at station 0+60.

The batch plant was slow adjusting to the new mix, and as a result, the paving was stop and go throughout most of the section.

Up to station 1+00, within 6 to 8 ft of the inner edge, the PCC had to be hand finished a lot due to a semi-rough surface.

At close to station 3+00, at 2:00 p.m., the batch plant was starting to keep up with the PCC trucks.

From station 3+40 to 4+50, the PCC surface was very rough. The inner edge within 6 ft was filled by hand with PCC and finished. The average speed of the paver at this point was 2.2 ft/min.

Behind the DBI, the grooves left by the forks on the DBI were very deep. The transverse construction joint was placed at station 8+89.

Following paving, shrinkage cracks were present in the vicinity of station 3+55.

Section 320209

Paving took place on July 18, 1995, beginning at close to 10:00 a.m. At the start of the transition area, about 60 ft of the PATB mat and fabric were torn up on the inner edge by the paver.

At the start of paving, about every other tie bar was pounded in with a hand mallet due to equipment problems.

The concrete placed between stations 0+55 and 1+15 sat in the trucks for up to 20 minutes. From station 0+05 to 1+05, PCC was hand placed 6 to 8 ft from the inner edge and finished by hand. From station 0+55 to the end of the sections, a PCC slurry was shoveled in front of the clary finisher on the inner edge to fill in rough spots.

From station 1+85 to the end of the section, the transverse tie bars were pounded in with a shovel blade.

At 11:40 a.m, rain began to fall for about 15 minutes. From about station 1+05 to 3+55 the surface of the PCC showed dimples from the rain. At 12:05, rain began to fall again, and dimples were present from station 3+55 to 4+05.

Paving stopped at station 5+55 for about 15 minutes while working on the DBI. A dowel bar became lodged in the machine and had to be cut out. Paving was completed at 1:00 p.m. A cold joint was placed at station 6+25.

Prior to paving this section, the PATB sagged slightly where the outlet trenches were placed. The sagging was especially bad at station 4+47.

Section 320210

Paving began in the evening on July 28, 1995 at 7:00 p.m. A different operation was used for this section than previously. Following the paver, the surface was finished and tined, followed by the curing compound and the watering bridge. The following stops occurred during paving: station 0+05 for 4 minutes, station 1+01 for 3 minutes, station 1+80 for 4 minutes, station 2+10 for 3 minutes.

From station 0+00 to 0+20, 12 ft from the inner edge, hand filling and finishing was required due to a rough finish. The PCC in front of the DBI was watered periodically, but the PATB was not watered.

Section 320211

Paving took place on July 20, 1995. Prior to paving, the geotextile that was placed in the trench was folded over the PATB. Over this, a 3 ft wide strip of geotextile was placed. The first three loads of PCC were dumped at close to 8:45 a.m., just prior to the sampling area. These loads were watered down on the grade after being dumped. The PATB was also watered down thoroughly prior to paving.

The DBI stopped at stations 0+05, 0+10, and 0+40 for close to 5 minutes to check the dowel bar depths. The speed of the paving train was approximately 5 ft/min counting the stops for dowel bar insertion.

The PCC was watered down periodically in front of the DBI. The DBI stopped at station 4+10 for 10 minutes to dump concrete in front of the DBI. Six trucks waited for 10 to 20 minutes at this point.

At station 4+00, there was a rough finish on the surface of the PCC 1 to 2 ft from the inner edge. The edge was okay at this point. Paving was completed at close to 12:30 p.m.

Between stations 4+50 and 5+00, the PATB was torn up in several places where trucks had made U-turns during hauling.

After the fifth load of PCC, the 3/4 in aggregate was reduced 2 percent, and the fines were increased 2 percent.

Section 320212

This section was placed over PATB. Paving took place on July 25, 1995. Paving began at approximately 5:15 a.m. The following stops occurred during paving: station 0+50 for 22 minutes and station 9+65 for 13 minutes.

The PATB was watered approximately every ½ hour. From about station 10+60 to the cold joint at station 11+90, a lot of hand filling and finishing was required 5 ft in from the inner edge. Paving at the cold joint was finished at 12:25 p.m.

On August 4th, the PCC and PATB began to be torn out between stations 0+40 and 10+93. There had been extensive cracking following paving and it was determined that the section would not perform as desired, therefore it was decided to tear it up. The removal continued on August 7th and 8th.

On August 10th, a lift of cement treated base was placed. Originally, the DGAB was to remain intact, but up to an inch was scraped out during the PCC and PATB removal. The actual CTB thickness varied from 4-1/2 in to 5-1/2 in.

On August 12th, repaving of this section began at 5:30 a.m. A 10.5 in lift of the NDOT PCC mix was placed between stations 0+40 and 10+93.

The paving began at close to 5:00 a.m. The following stops occurred during paving:

- station 0+90 for 17 minutes
- station 1+60 for 6 minutes
- station 2+30 for 5 minutes
- station 3+10 for 5 minutes
- station 5+60 for 6 minutes.

Tie bars were inserted at both the centerline joint and also the lane to outside shoulder joint. The bars in the lane/shoulder joint were inserted by hand.

No watering bridge was used to pave this section. The DBI was followed by the paver, the tining machine, and the curing machine.

Section 320259

Paving was completed on July 14th. Paving in the monitoring section began at close to 12:00 p.m. Rumble strips were placed along the outer edge of the PCC, and tended to bow out in a few spots. These spots were hand finished with trowels.

The paving train stopped for 9 minutes at station 2+45. The dowel bars were only 2 ft below finished grade. Another stop was at station 2+55 for 15 minutes, and again at station 3+00 for 10 minutes. From station 2+70 to 4+70, the dowel prongs were lowered manually without external vibration. The automatic vibration system was being fixed during this time.

There were many stops during the manual insertion for close to 5 minutes. There was a 25 minute stop at station 4+15 waiting for PCC trucks. At station 4+80, a 12 ft 2x10 was used to form up the inner edge. Paving was completed at close to 2:30 p.m.

Tie bars were inserted at both the centerline joint and the lane/outside shoulder joint in this section.

IV. SUMMARY - NEVADA SPS-2 CONSTRUCTION

SUBGRADE/EMBANKMENT

Excavation of unsuitable material and lime stabilization of the natural subgrade were performed as per the Nevada SPS-1 project. Soil stabilization began on June 2nd. Fill operations began on June 6th, and were completed on June 19th.

DENSE GRADED AGGREGATE BASE

Placement of the DGAB took place on June 21st, 26th, 27th, and 28th. An MC-250 liquid asphalt was used to prime the surface of all DGAB sections on June 28th. The DGAB was placed 6 in thick on sections 320101, 320102, 320103, and 320104, and 4 in thick on sections 320209, 320210, 320211 and 320212. The DGAB was placed directly on the embankment in all eight sections.

PERMEABLE ASPHALT TREATED BASE

Four inches of PATB was placed on sections 320209, 320210, 320211, and 320212 on July 10th and 11th. The PATB was placed on 4 in of DGAB, in one lift, in three passes.

During paving of the SPS-2 sections, the PATB material was loaded directly into the paver's hopper using end dump trucks. The SPS-1 PATB paving used a Clarco cocal machine to load the material into the paver.

Edge drains were placed prior to PATB paving from June 29th through July 6th. A construction fabric was used in the trenches and extended 4 ft under the PATB.

LEAN CONCRETE BASE

Six inches of LCB was placed on sections 320205, 320206, 320207, and 320208. Paving began on July 6th and was completed on July 8th. The LCB was placed directly on the embankment in all four sections.

PORTLAND CEMENT CONCRETE

The 12 SHRP SPS-2 test sections received PCC thicknesses of either 8 in or 11 in. Dowels were machine-placed at the transverse joints and tie bars at the centerline longitudinal joint. State section 320259 received a 10.5 in PCC layer. Dowels were machine-placed at the transverse joints and tie bars at both the centerline joint and lane/shoulder joint. Paving began on July 14th in section 320259, and going eastbound was completed on July 31st in section 320206.

Section 320212 had severe shrinkage cracking following paving and was removed on August 4th. The PATB was also torn out. Five inches of CTB was placed in the excavation followed by a 10.5 in lift of NDOT PCC mix. This section will be included in the SHRP study as a state supplemental section, and the original section 320212 will no longer exist.

Problems were encountered placing the 750 psi concrete. Most of the mix placed was extremely stiff and would tear during placement. At times, the mix was so stiff the paving machine would spin the tracks and would be very close to being stopped. To attain the 750 psi requirements, the water cement ratio was low at 0.30. NDOT specifications require the contractor to take Kelly Ball readings from a platform at the batch plant on every truck load. This is done to control the slump of the mix. At the plant, several of the Kelly Ball readings showed too high of a slump. The contractor would adjust the mix by increasing the water reducing agent and lowering the moisture content. This helped the problem at the plant, but appears to have contributed significantly to the placement problems. Even though the plant was only one mile from the placement area, it appears that the water cement ratio was so low that flash set was occurring on grade prior to placement and finishing. The contractor made several adjustments throughout these sections, but did not inform anyone that the adjustments had been made.

V. KEY OBSERVATIONS - NEVADA SPS-2

As this project was constructed over an existing section of highway, the removal of the existing pavement structure was required. When this was performed, the subgrade, which was a sandy silt, was found to be out of specifications for NDOT subgrade material. This required the lime stabilization of the top one foot of subgrade material.

After this stabilization, embankment material was placed and compacted. FWD testing on the embankment showed that sections 320201, 320205, 320207, and 320209 had significantly higher deflections than the other sections.

The dense graded aggregate base (DGAB) was placed on eight of the twelve sections. The material was placed in either one or two lifts, depending on the design thickness. Sections 320201 and 320209 were found to have high variations in deflections during FWD testing, and section 320203 had deflections in the first 125 feet, while the other five sections were more consistent.

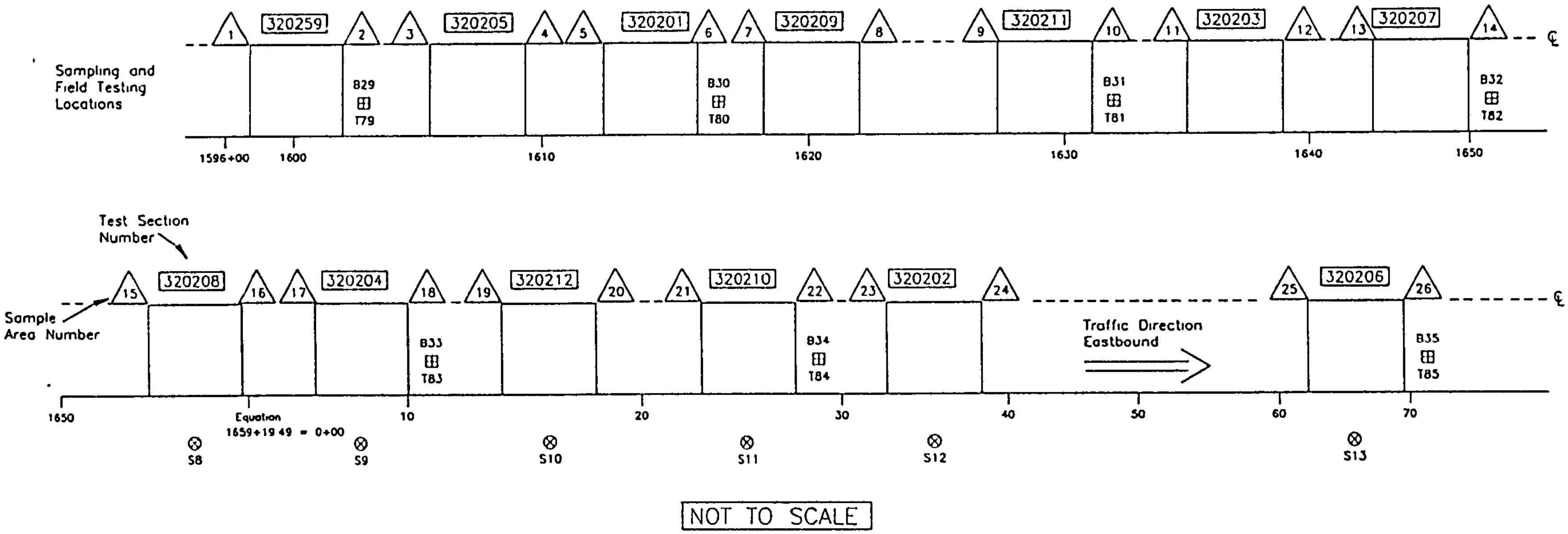
Four sections received a 4 in permeable asphalt treated base (PATB). Edge drains were constructed on these sections utilizing a geotextile and open graded rock placed in trenches.

Four sections had a 6 in lean concrete base (LCB) placed directly on the embankment. The LCB was placed in one 40 ft wide pass and there were no joints sawed. All sections except 320206 exhibited extensive cracking within two weeks of paving.

The Portland cement concrete (PCC) consisted of three different mixes. Section 320259 was the state standard mix, while the other 12 sections had six sections of a 475 psi mix and six sections of a 750 psi mix. The typical SPS-2 project has six 550 psi and six 900 psi mixes, but it wasn't possible to reach the 900 psi target using local materials and, therefore, the target strengths were revised. There were a number of problems encountered during PCC paving that will be discussed on a section-by-section basis. Section 320201 had sections that needed to be hand-finished and shrinkage cracks appeared shortly after paving. Section 320202 had several areas of tearing in the lat 300 ft. Within a day of paving section 320203, shrinkage cracks appeared. There was tearing of the PCC in the areas around the dowel bar inserter (DBI) on section 320204. Transverse tie bars had to be pounded in by hand for the first 290 ft of section 320205 due to an equipment failure and there were a number of areas that required hand finishing. Shrinkage cracks also developed in sections 320205 and 320208. Section 320209 had to have approximately every other tie bar pounded in with a hand mallet due to equipment problems. It rained for about 15 minutes, which resulted in about 200 ft of the surface of section 320209 dimpled. After the fifth load of PCC on section 320211, the 3/4 in aggregate was reduced by 2% and the fines were increased by 2%. Section 320212 exhibited such severe cracking after paving, that it was removed and replaced with nonconforming materials, thereby removing it from the study.

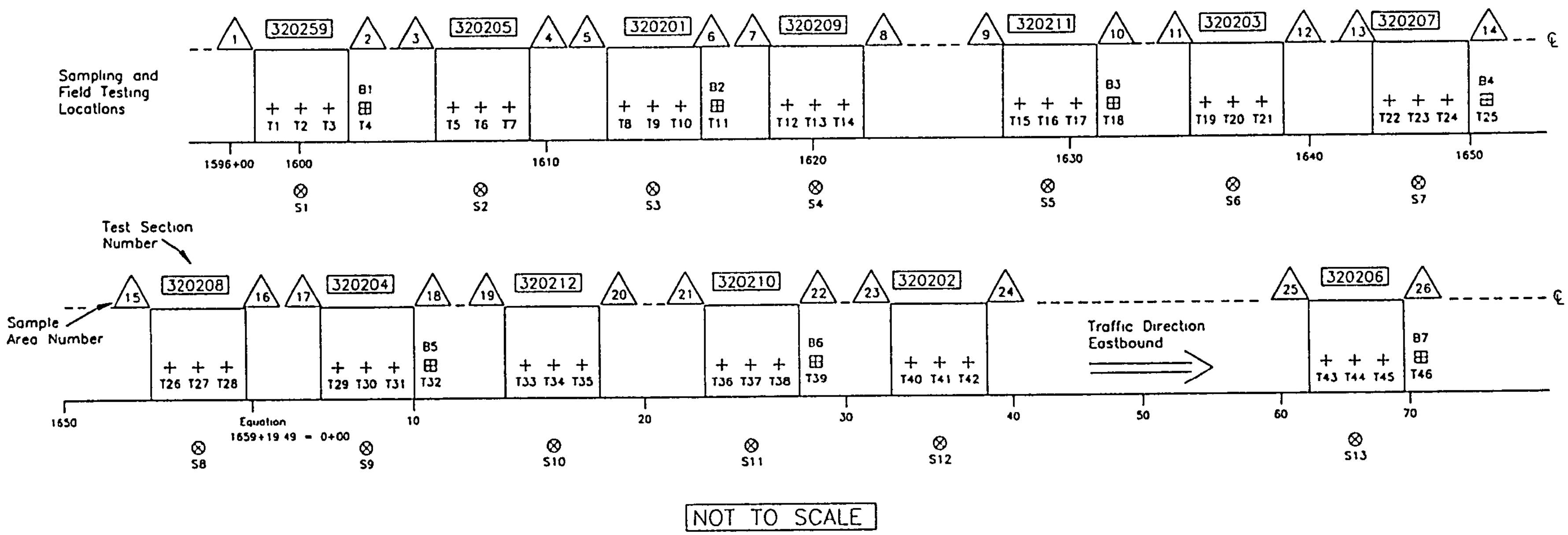
The majority of the problems with the PCC paving came as a result of the mixes being significantly different than those typically used by the paving crew. This was especially true for the 750 psi mix. Proof of this fact is that section 320259, which was the state standard mix, had none of the problems with shrinkage cracks and tearing that were so common for the majority of the project. The primary conclusion that can be made on the basis of this project is that trying to perform non-standard construction can cause significant problems. It is highly unlikely that the majority of the test sections will last anywhere close to their design lives.

APPENDIX A
NEVADA SPS-2 SAMPLING PLAN



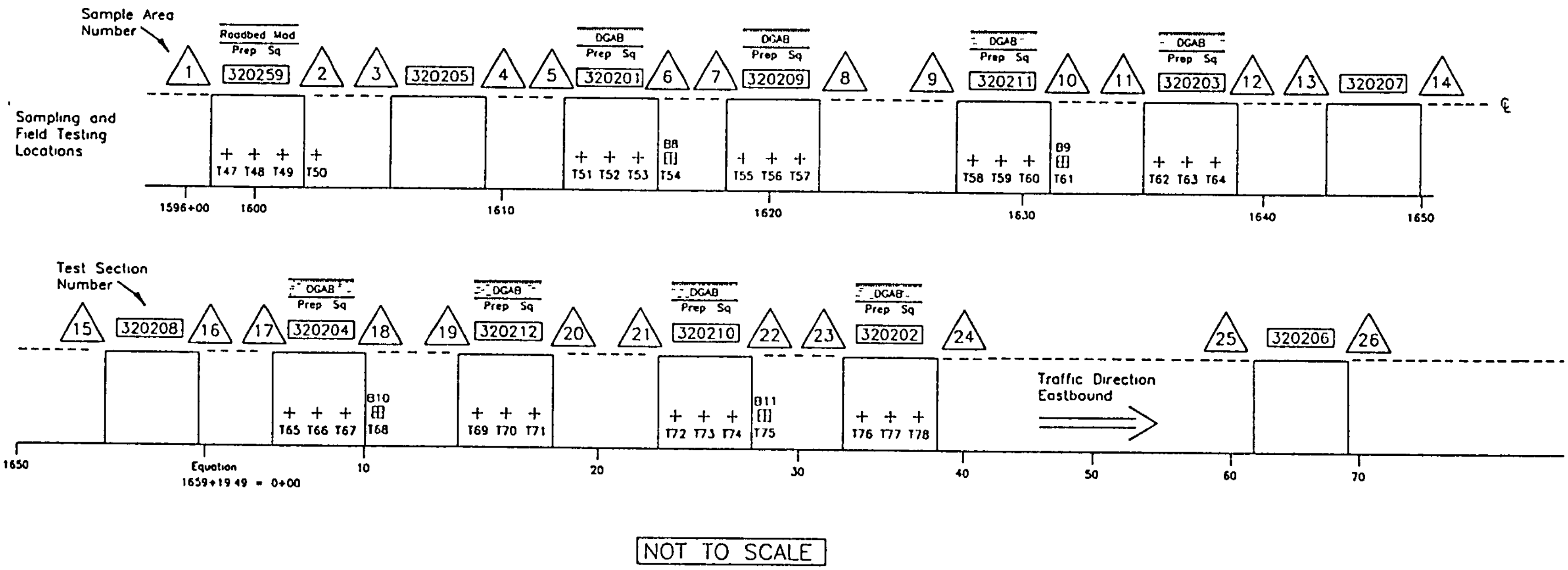
□ 2' x 2' bulk sampling location (B29–B35) to 12" below top of subgrade
\+ Location of nuclear moisture–density tests (T79–T85)
△ Sample areas

Figure A1. Overview of material sampling and testing on natural subgrade, NV SPS-2.



□ 2' x 2' bulk sampling location (B1–B7) to 12" below top of subgrade
⊗ Shoulder probe (S1–S13)
+ Location of nuclear moisture–density tests (T1–T46)
△ Sample areas

Figure A2. Overview of material sampling and testing on embankment, NV SPS-2.



□ Bulk sampling location of DGAB (B8–B11)

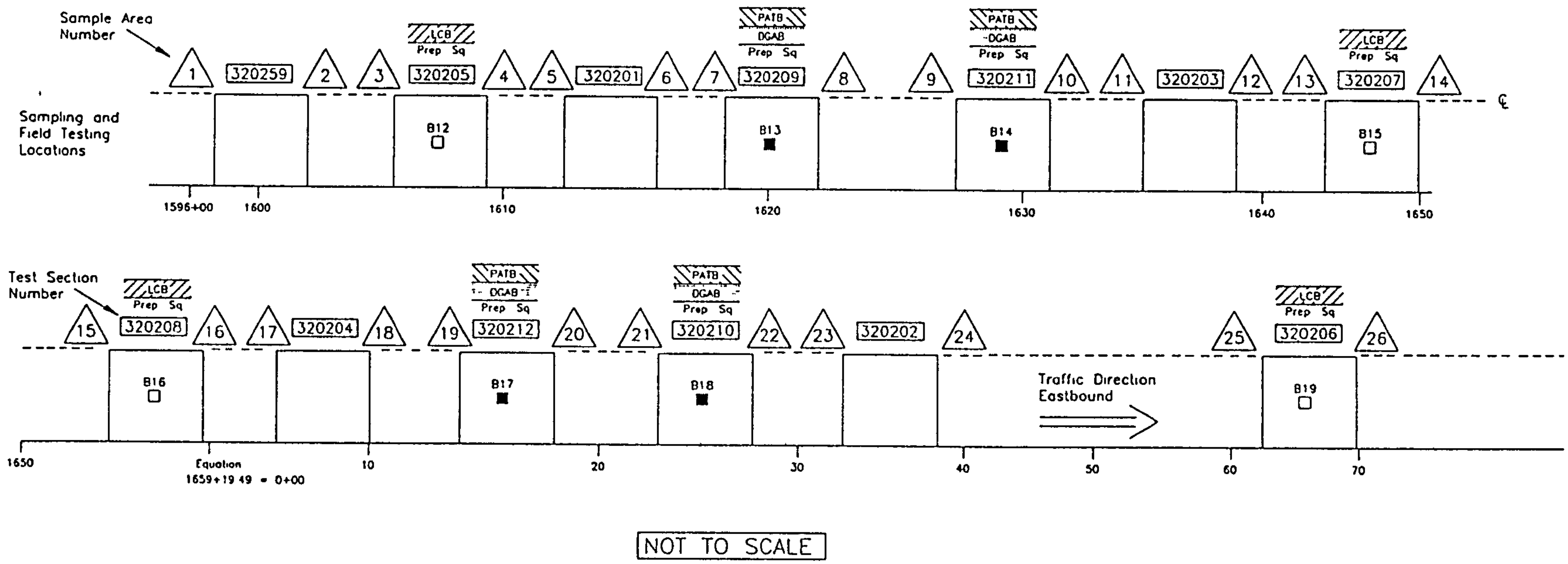
\+ Location of nuclear moisture-density tests (T47–T78)

Prep. Sq. – Prepared Subgrade

DGAB – Dense Graded Aggregate Base

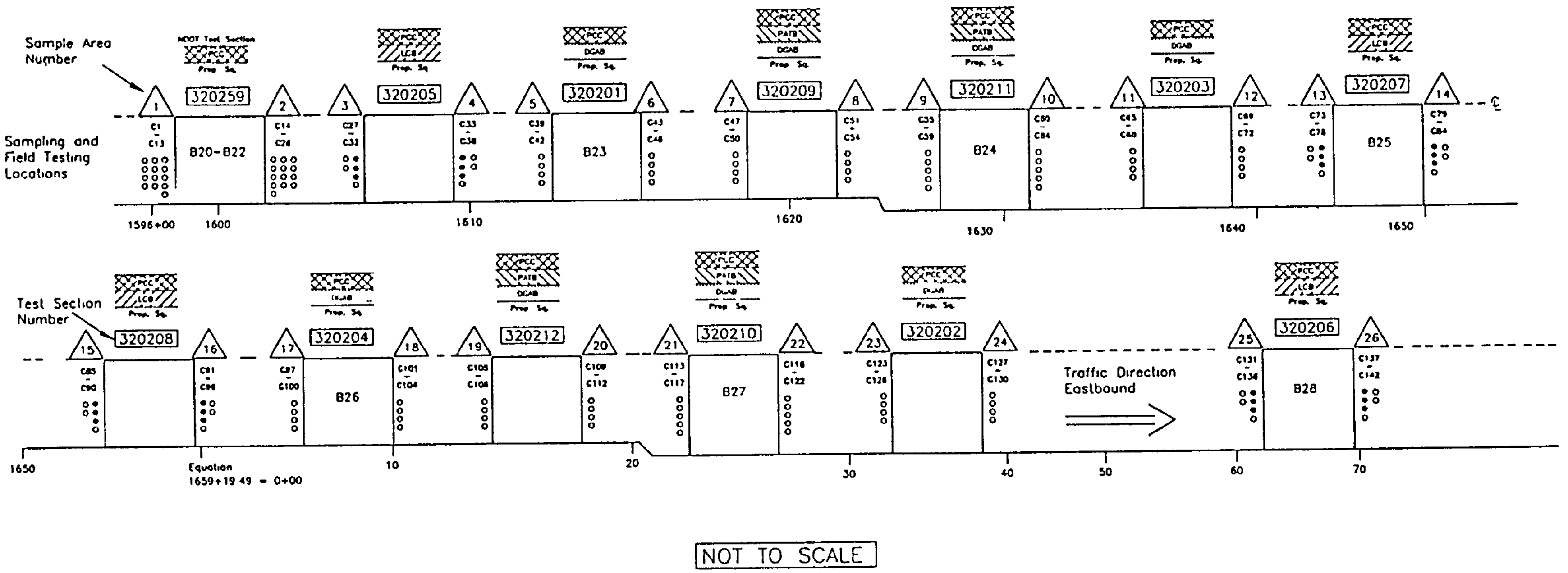
△ Sample areas

Figure A3. Overview of material sampling and testing on dense graded aggregate base, NV SPS-2.



□ Bulk LCB samples (B12, B15, B16, B19)
■ Bulk PATB samples (B13, B14, B17, B18)
Prep. Sg. – Prepared Subgrade
DGAB – Dense Graded Aggregate Base
LCB – Lean Concrete Base
PATB – Permeable Asphalt Treated Base
△ Sample areas

Figure A4. Overview of material sampling and testing on lean concrete base and permeable asphalt treated base, NV SPS-2.



- 4" Core of finished PCC and/or LCB layers
  (C29-C31, C33-C35, C75-C77, C79-C81, C87-C89, C91-C93, C133-C135, C137-C139)
- o 4" Core of finished PCC surface only
  (C1-C28, C32, C36-C74, C78, C82-C86, C90, C94-C132, C136, C140-C142)

Test section from which bulk samples of PCC obtained (B20-B28)

LCB - Lean Concrete Base

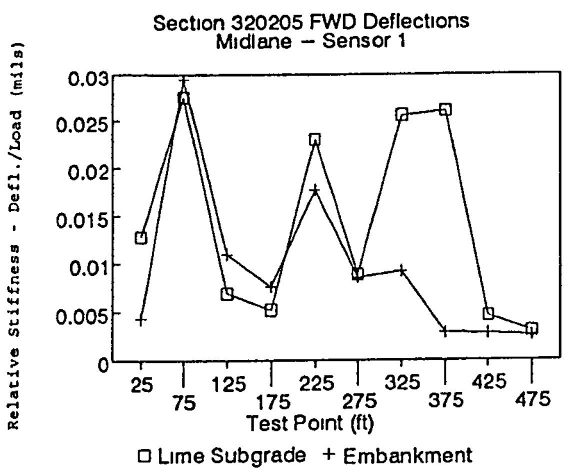
DGAB - Dense Graded Aggregate Base

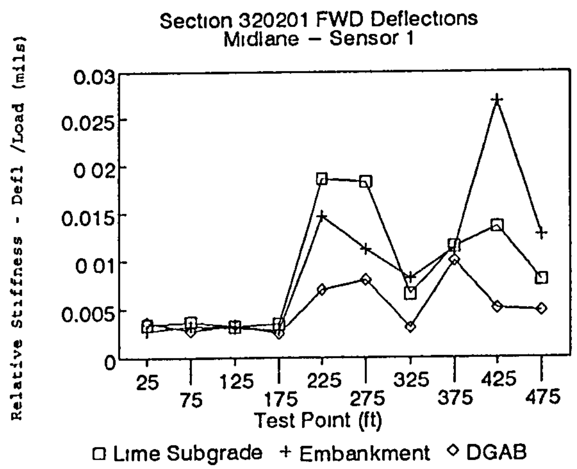
PATB - Permeable Asphalt Treated Base

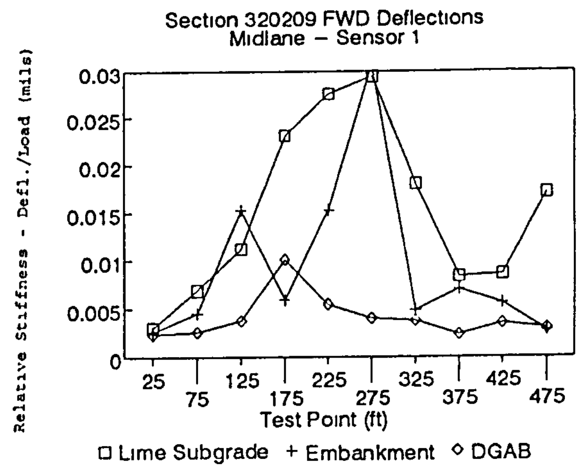
PCC - Portland Cement Concrete

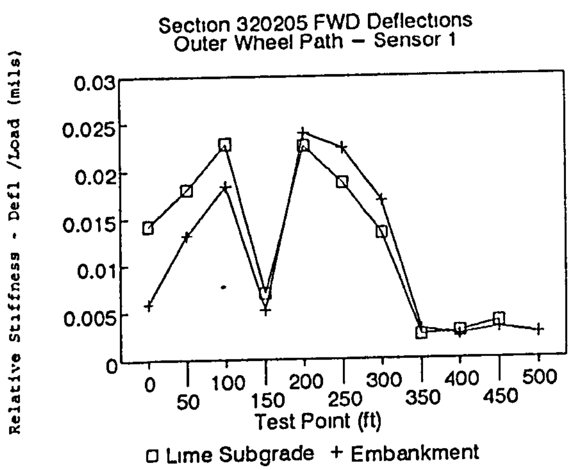
Figure A5. Overview of sampling, testing, and coring plan on PCC surface, NV SPS-2.

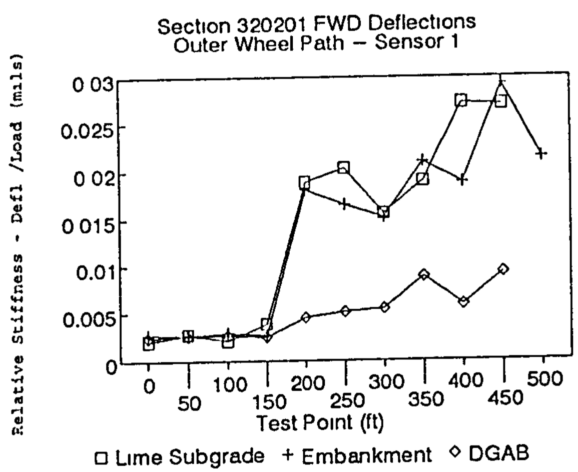
APPENDIX B
NEVADA SPS-2 FWD DEFLECTION PLOTS

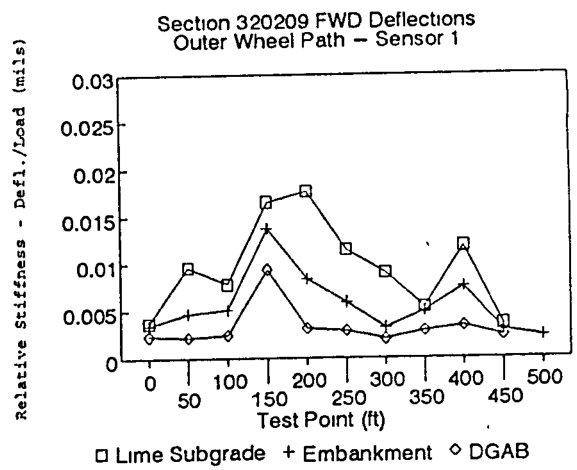

Section 320205 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
Lime Subgrade
Embankment

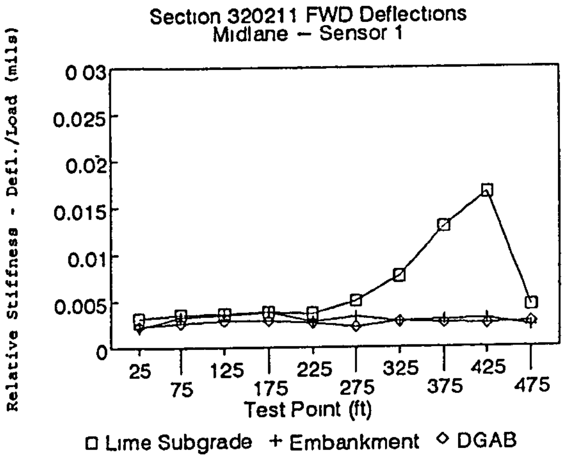

Section 320201 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl /Load (mils)
Test Point (ft)
Lime Subgrade
Embankment
DGAB

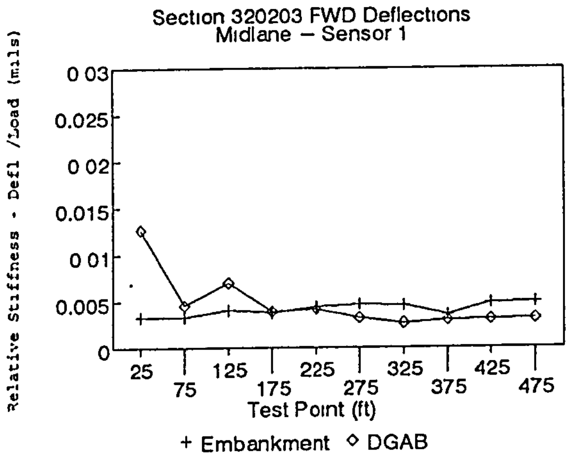

Section 320209 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
Lime Subgrade
Embankment
DGAB

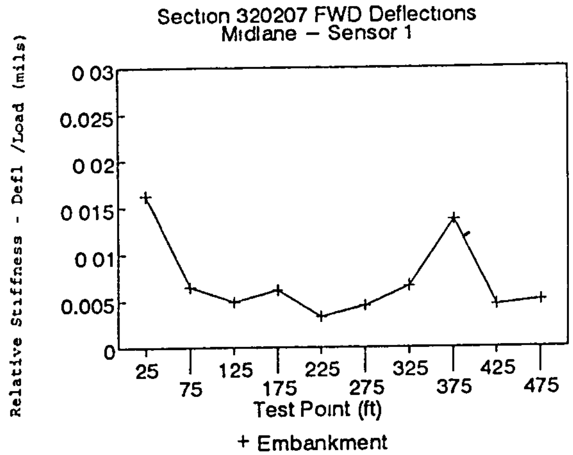

Section 320205 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl /Load (mils)
Test Point (ft)
Lime Subgrade
Embankment

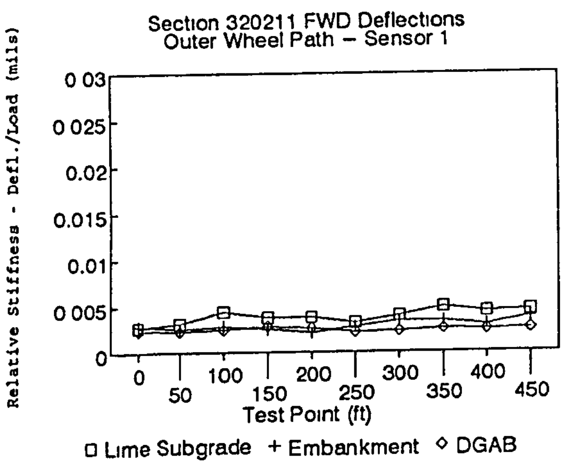

Section 320201 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl /Load (mils)
Test Point (ft)
Lime Subgrade
Embankment
DGAB

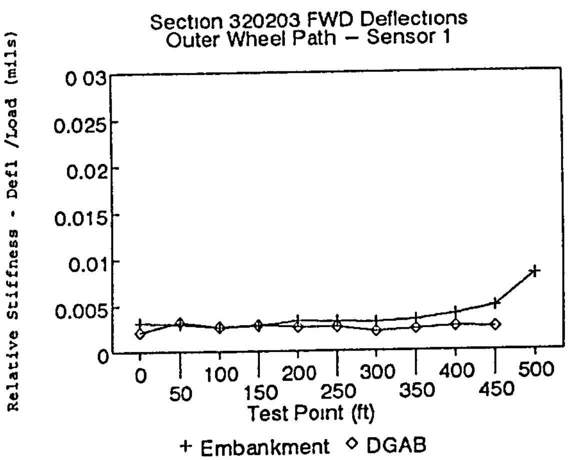

Section 320209 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
Lime Subgrade
Embankment
DGAB

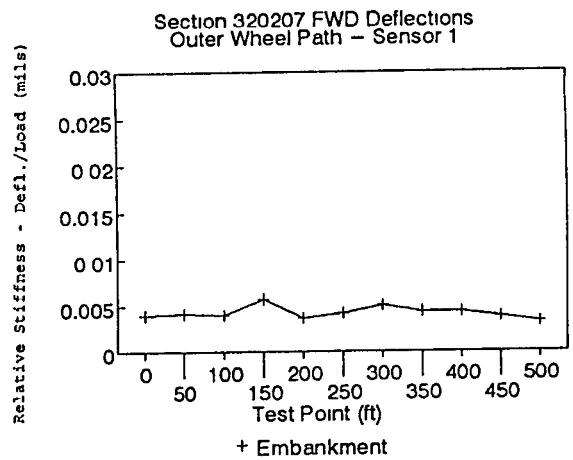

Section 320211 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
0.03
0.025
0.02
0.015
0.01
0.005
0
25 75 125 175 225 275 325 375 425 475
Test Point (ft)
□ Lime Subgrade + Embankment ◇ DGAB

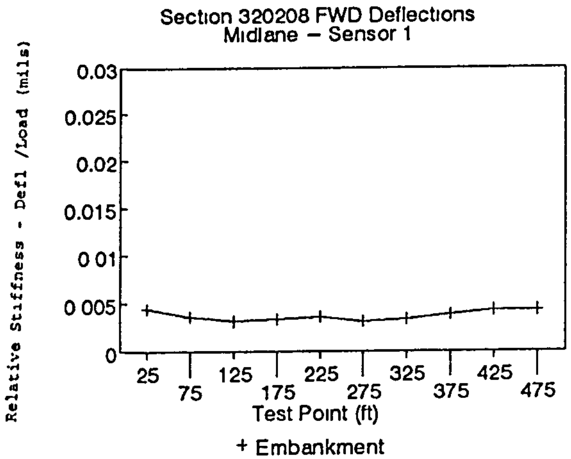

Section 320203 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
0.03
0.025
0.02
0.015
0.01
0.005
0
25 75 125 175 225 275 325 375 425 475
Test Point (ft)
+ Embankment ◇ DGAB

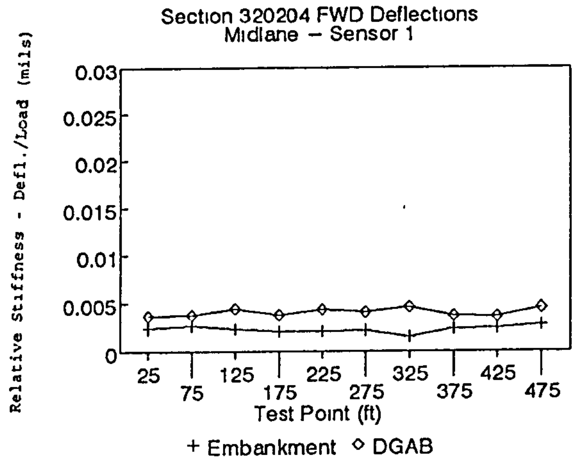

Section 320207 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
0.03
0.025
0.02
0.015
0.01
0.005
0
25 75 125 175 225 275 325 375 425 475
Test Point (ft)
+ Embankment

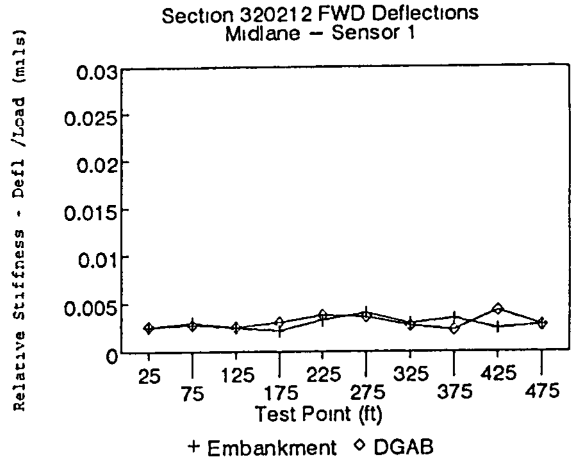

Section 320211 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
0.03
0.025
0.02
0.015
0.01
0.005
0
0 50 100 150 200 250 300 350 400 450
Test Point (ft)
□ Lime Subgrade + Embankment ◇ DGAB

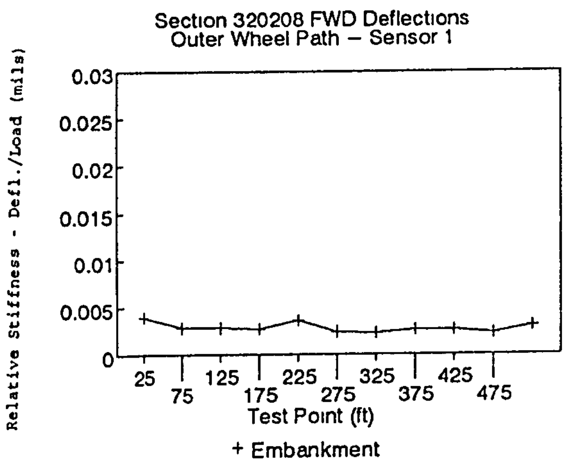

Section 320203 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
0.03
0.025
0.02
0.015
0.01
0.005
0
0 50 100 150 200 250 300 350 400 450 500
Test Point (ft)
+ Embankment ◇ DGAB

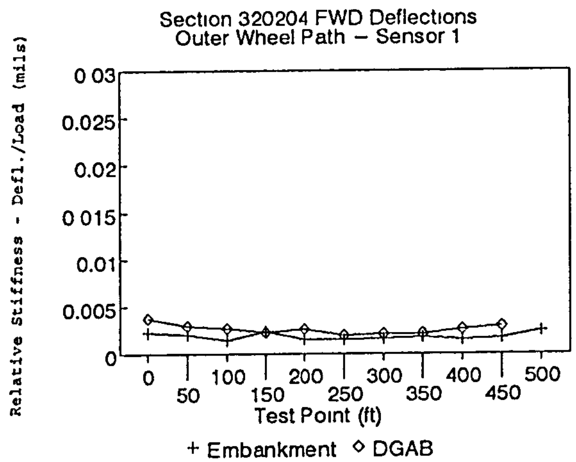

Section 320207 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
0.03
0.025
0.02
0.015
0.01
0.005
0
0 50 100 150 200 250 300 350 400 450 500
Test Point (ft)
+ Embankment


Section 320208 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl /Load (mils)
Test Point (ft)
+ Embankment


Section 320204 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
+ Embankment ◇ DGAB


Section 320212 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl /Load (mils)
Test Point (ft)
+ Embankment ◇ DGAB


Section 320208 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
+ Embankment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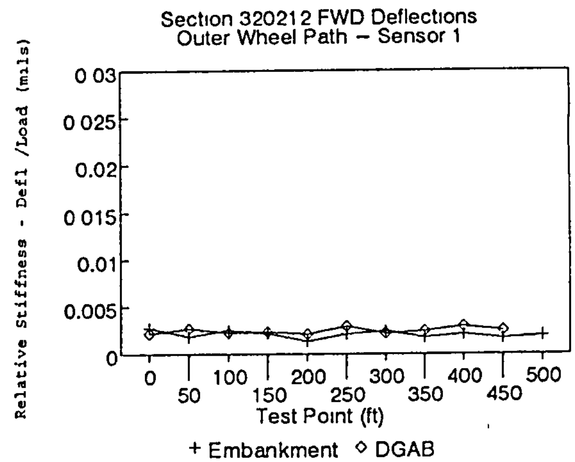
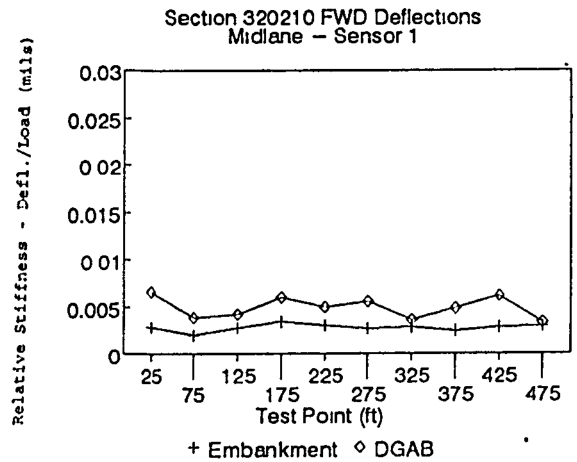
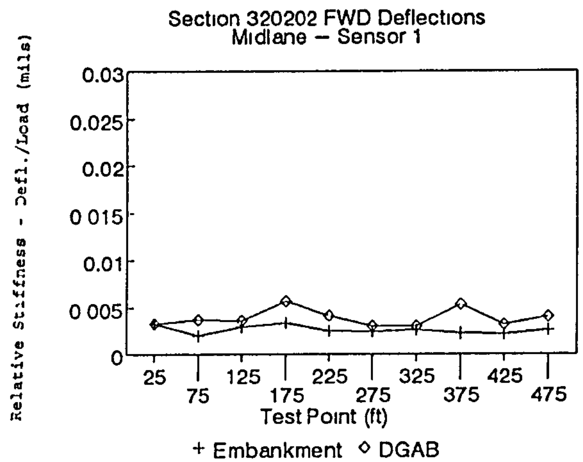
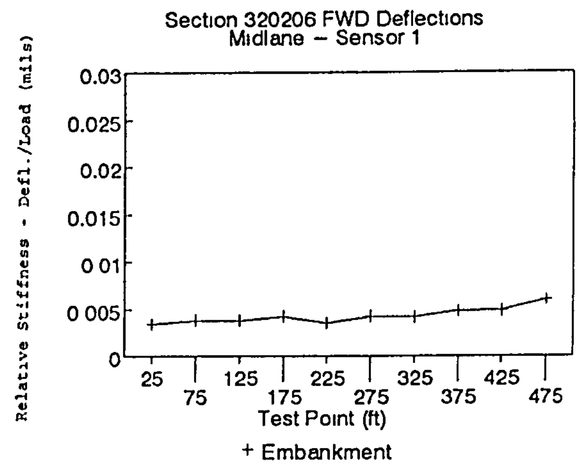
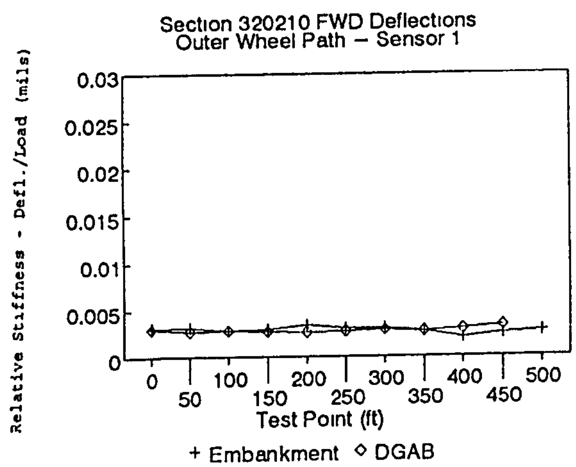
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
Test Point (ft)
+ Embankment ◇ DGAB

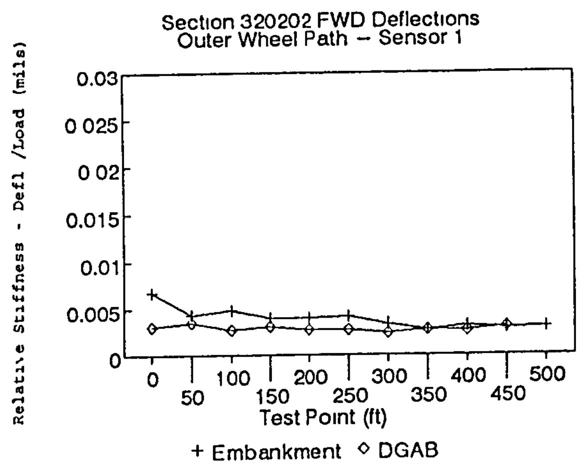

Section 320212 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl /Load (mils)
Test Point (ft)
+ Embankment ◇ DGAB

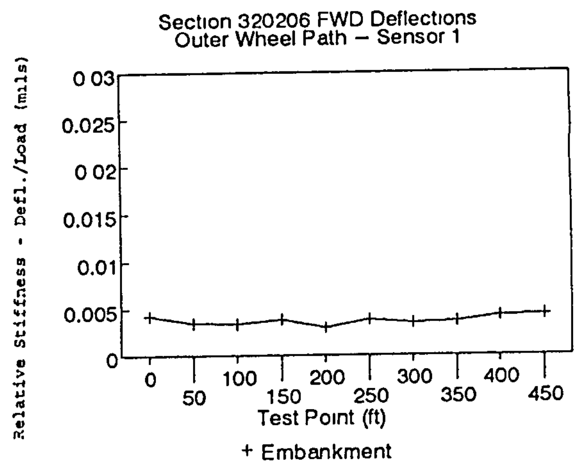

Section 320210 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
0
0.005
0.01
0.015
0.02
0.025
0.03
25
75
125
175
225
275
325
375
425
475
Test Point (ft)
+ Embankment ◇ DGAB


Section 320202 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
0
0.005
0.01
0.015
0.02
0.025
0.03
25
75
125
175
225
275
325
375
425
475
Test Point (ft)
+ Embankment ◇ DGAB


Section 320206 FWD Deflections
Midlane – Sensor 1
Relative Stiffness - Defl./Load (mils)
0
0.005
0.01
0.015
0.02
0.025
0.03
25
75
125
175
225
275
325
375
425
475
Test Point (ft)
+ Embankment


Section 320210 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
0
0.005
0.01
0.015
0.02
0.025
0.03
0
50
100
150
200
250
300
350
400
450
500
Test Point (ft)
+ Embankment ◇ DGAB


Section 320202 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
0
0.005
0.01
0.015
0.02
0.025
0.03
0
50
100
150
200
250
300
350
400
450
500
Test Point (ft)
+ Embankment ◇ DGAB


Section 320206 FWD Deflections
Outer Wheel Path – Sensor 1
Relative Stiffness - Defl./Load (mils)
0
0.005
0.01
0.015
0.02
0.025
0.03
0
50
100
150
200
250
300
350
400
450
Test Point (ft)
+ Embankment

APPENDIX C
NEVADA SPS-2 PRIME COAT TESTS - DGAB

PRIME on DGAB
SPS-2

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
1263 S. Stewart, C.C., Nv. 89712

Lab Test# CCBL-96-000

JUL 13 1995

REPORT OF TESTS OF BITUMINOUS LIQUIDS

Date Reported	07/12/95	Cont. No.	2591
Nevada Specification, MC-250		Project No.*	SPI-080-3(12)
Manufacturer	HUNTWAY	County	HU/LA
Shipping Point	BENICIA, CA.	Field Number	15
Contractor	MATICH	APO Number	
Sampled By	CONTRACTOR	Wt Ticket No.	367726
Observed By	C. MCDERMOTT	Refinery No.	367726
Tests By	DY	Truck/trailer	163/
Date Sampled	06/28/95	Quantity	15.46
Date Received	07/07/95	Date Tested	07/11/95

JUL 17 1995

TESTS PERFORMED	TEST RESULTS	RETEST	SPECIFICATIONS
Flash Point, °F (T48) or (T79)			(°C) Minimum 150 °
Original Viscosity 60°C(140°F),cSt (T201)	(431) 431		(mm²/s) 250-500 cSt
Water Mass % (T55)			Maximum 0.2 %
Distillation: % of Total Distillate (T78)			
To 218°C (424°F)	0.0		Maximum 10.0
To 252°C (486°F)			15.0-55.0 %
To 307°C (585°F)	12.2	11.6	60.0-87.0 %
Percent Residue By Distillation To 351°C (664°F) (T78)	89.3		Minimum 67 %
% Total Distillate To 351°C (664°F) (T78)			- %
Residue Visc. 60°C (140°F), Poises (T202)	(3) 29	(3) 28	(Pa·s) 300-1200 Poise
Residue Viscosity 60°C(140°F), cSt (T201)			(mm²/s) - cSt

REMARKS AND RECOMMENDATIONS: **MATERIAL HAS FAILED NEVADA SPECIFICATIONS**

TOTAL 73 DEMERIT(S)

MATERIAL FAILED DISTILLATION, ASSHTO T78, AND RESIDUE VISCOSITY, ASSHTO T202.

DISTRIBUTION:

1 District Engineer
1 Resident Engineer
1 Laboratory
1 Oil Producer
1 Construction

1 Contractor
State Purchasing
Maintenance Engineer
L.V. Facility

Michael A. Dunn

* Other Project Numbers May Be Applicab

APPENDIX D
NEVADA SPS-2 LCB MIX DESIGN

LCB

MIX DESIGN

NEVADA DEPARTMENT OF TRANSPORTATION
CONCRETE MIX DESIGN SUBMITTAL FORM

Contract No.: NDOT Contract No. 2591
Mix Identification No:. Lean Concrete Base (Mix #21)
Designed By: Kleinfelder, Inc , B. Duc

Producer: Kleinfelder Lab Trial Batch
Date Submitted: 03/20/95
Tested By: Kleinfelder, Inc

COMPONENTS: TYPE & SOURCE

Fly Ash: - - -
Cement: Nevada Type II - Low Alkali
Aggregate:
No.: 67 Coarse: NDOT Dept 83-06
Fine: Silver State Pit
Fine: NDOT Dept. 83-06 - Crusher Waste
Water: Domestic
Air Admixture: Master Builders - Pave Air 90
Other: - - -

DESIGN REQUIREMENTS

NDOT Class: Lean Concrete Base
Compressive Strength, psi: 500 ± 50 @ 7 days
Slump, in.: 1.0 - 3.0
Air Content, %: 4 0 - 9 0
Theo. Unit Weight, pcf: 137.9 pcf
Water/Cement Ratio: 1.23

MATERIAL QUANTITIES FOR 1 0 CUBIC YARD OF CONCRETE

		Solid Vol. Percent	Solid Vol Cubic Feet	Computed Batch Weight in Lbs @ SSD
Aggregates				
No.: 67	Coarse	50 0	10.21	1663
	Fine(Silver State Pit)	25.0	5.105	803
	Fine(Crusher Waste)	25.0	5 105	810
Cement @: 2.13 Sacks / Yard			1.02	200
Fly Ash @:			-	-
Water: 29.53 Gallons			3 94	246
Air Content: 6.0%			1 62	-
Air Admixture @: 2.0 oz/cwt			-	4 0 oz
Water Reducer @:			-	-
		TOTALS:	27 00	3722

TRIAL BATCH TEST RESULTS

Slump: 1.25 in. Air: 4.3%

DATE MIXED. 03/10/95
Unit Weight: 138.4 pcf

Sample No.	Date Tested	Age in Days	Area of Cylinder	Total Load	PSI	Avg	Remarks
3522A	03/13/95	3	28.21	5,780	200		
3522B	03/13/95	3	28.21	6,662	240	220	
3522C	03/17/95	7	28 20	13,139	470		
3522D	03/17/95	7	28.20	13,709	490		
3522E	03/17/95	7	28 20	14,526	520		
3522F	03/17/95	7	28 20	13,793	490		
3522G	03/17/95	7	28.20	14,430	510	500	

Signed By: Donald R. Curphey
Donald R. Curphey, P.E.
Senior Engineer

For: Kleinfelder, Inc

F3\504a

No 30 1649-07 001

State 4000 psi design (Compressive)

NEVADA DEPARTMENT OF TRANSPORTATION
CONCRETE MIX DESIGN SUBMITTAL FORM

Contract No.: NDOT Contract No. 2591
Mix Identification No:. PCCP (Mix #2B)
Designed By: EB/JR

Producer: Laboratory Trial Batch
Date Submitted: 01/30/95
Tested By: Kleinfelder, Inc : RR/VS/RP/SW

COMPONENTS: TYPE & SOURCE

Fly Ash: N.A.
Cement: Nevada Type 1P
Aggregate:
No.: 4 Coarse: NDOT Dept 83-06
No.: 67 Coarse: NDOT Dept 83-06
Fine: Silver State Pit
Water: Domestic
Air Admixture: Master Builders - Pave Air 90
Other: Master Builders - Master Pave-N

DESIGN REQUIREMENTS

NDOT Class: PCCP
Compressive Strength, psi 4000 +20 %= 4800
Slump, in.: 1.0 - 3.0
Air Content, %: 4.0 - 6.0
Theo. Unit Weight, pcf 141.0

MATERIAL QUANTITIES FOR 1.0 CUBIC YARD OF CONCRETE

		Solid Vol. Percent	Solid Vol. Cubic Feet	Computed Batch Weight in Lbs @ SSD
Aggregates				
No.. 4	Coarse	29.0	5.32	866
No.: 67	Coarse	33.0	6.04	984
	Fine	38.0	6 97	1097
Cement @: 6.5 Sacks/Yard			3 32	611
Fly Ash @: -			-	-
Water: 30.0 Gallons			4.00	249.9
Air Content: 5.0%			1 35	-
Air Admixture @: 2.3 oz/cwt			-	14.0 oz
Water Reducer @: 2.0 oz/cwt			-	12.0 oz
		TOTALS:	27.00	3807 9

TRIAL BATCH TEST RESULTS

DATE MIXED: 01/23/95

Slump: 1.5 in. Air: 4.4%

Unit Weight 142 4 pcf

Sample No	Date Tested	Age in Days	Area of Cylinder	Total Load	PSI	Avg	Remarks
3411A	01/26/95	3	28 16	109,038	3,870		
3411B	01/26/95	3	28 16	96,281	3,420	3,645	
3411C	01/30/95	7	28.27	111,075	3,930		
3411D	01/30/95	7	28.27	112,386	3,980	3,960	
3411E	02/06/95	14	28.25	125,872	4,460		
3411F	02/06/95	14	28.25	129,730	4,590	4,530	
3411G	02/20/95	28	28.21	144,521	5,120		
3411H	02/20/95	28	28 21	146,602	5,200		
3411I	02/20/95	28	28 21	140,729	4,990		
3411J	02/20/95	28	28 21	135,934	4,820		
3411K	02/20/95	28	28.21	147,037	5,210	5,070	

Signed By: Donald R. Curphey
Donald R. Curphey, P.E.
Senior Engineer

For: Kleinfelder, Inc

F3150-1a

No 30-1049-07 001

475 psi

MIX DESIGN

NEVADA DEPARTMENT OF TRANSPORTATION

CONCRETE MIX DESIGN SUBMITTAL FORM

Contract No.: NDOT Contract No. 2591
Mix Identification No:. SHRP 550 Psi (Mix #9)
Designed By: EB/JR

Producer: Laboratory Trial Batch
Date Submitted: 03/27/95
Tested By: Kleinfelder, Inc : RR/VS/RP/SW

COMPONENTS: TYPE & SOURCE

Fly Ash: N.A
Cement: Nevada Type 1P
Aggregate:
No.: 4 Coarse: NDOT Dept 83-06
No.: 67 Coarse: NDOT Dept 83-06
Fine: Silver State Pit
Water: Domestic
Air Admixture: Master Builders - Pave Air 90
Other: Master Builders - Master Pave-N

DESIGN REQUIREMENTS

NDOT Class: PCCP
Flexural Strength, psi: 550
Slump, in.: 1.0 - 3.0
Air Content, %: 4.0 - 6 0
Theo. Unit Weight, pcf: 142 63

MATERIAL QUANTITIES FOR 1.0 CUBIC YARD OF CONCRETE

	Solid Vol. Percent	Solid Vol. Cubic Feet	Computed Batch Weight in Lbs @ SSD
Aggregates			
No.: 4 Coarse	29.0	5.81	946
No.: 67 Coarse	33.0	6.62	1078
Fine	38.0	7.62	1198
Cement @: 4.5 Sacks/Yard		2.30	423
Fly Ash @: -		-	-
Water: 24.75 Gallons		3.30	206.2
Air Content: 5.0%		1.35	-
Air Admixture @: 2.25 oz/cwt		-	9.5 oz.
Water Reducer @: 2.0 oz/cwt		-	8.5 oz.
TOTALS:		27.00	3851.2

TRIAL BATCH TEST RESULTS

Slump: 1.0 in. Air: 5.3%

DATE MIXED: 01/12/95

Unit Weight: 141.43 pcf

Sample No.	Date Tested	Age in Days	Calc. Area of Beam	Total Load	PSI	Avg	Remarks
3401C	01/19/95	7	216.5	5815	485		Third Pt
3401D	01/19/95	7	215.8	5546	465	475	Third Pt
3401E	01/26/95	14	216.8	5412	450		Third Pt
3401F	01/26/95	14	221.9	6000	485		Third Pt.
3401G	01/26/95	14	219.7	5673	465		Third Pt
3401H	01/26/95	14	219.3	5946	490	475	Third Pt.

Signed By: Donald R. Curphey
Donald R. Curphey, P.E.
Senior Engineer

For: Kleinfelder, Inc

No. 30-1649-07.001

750 psi

MIX DESIGN

NEVADA DEPARTMENT OF TRANSPORTATION
CONCRETE MIX DESIGN SUBMITTAL FORM

Contract No.: NDOT Contract No. 2591
Mix Identification No:. Mix #16 SHRP 900 PSI
Designed By: EB/JR

Producer: Laboratory Trial Batch
Date Submitted: 04/03/95
Tested By: Kleinfelder, Inc RH/LS/TJ

COMPONENTS: TYPE & SOURCE

Fly Ash: N.A.
Cement: Nevada Type 1P
Aggregate:
No.: - Coarse:
No.: 67 Coarse: NDOT - Dept. 83-06
Fine: Silver State Pit
Water: Domestic
Air Admixture: Master Builders - Microair
Other: Master Builders - Master Pave-N, Master Builders - Polyheed 997

DESIGN REQUIREMENTS

NDOT Class: PCCP
Flexural Strength, psi: 900
Slump, in.: 1.0 - 3.0
Air Content, %: 4.0 - 6.0
Theo. Unit Weight, pcf: 141 0
Water/Cement Ratio: 0.316

MATERIAL QUANTITIES FOR 1 0 CUBIC YARD OF CONCRETE

	Solid Vol Percent	Solid Vol. Cubic Feet	Computed Batch Weight in Lbs @ SSD
Aggregates			
No.: - Coarse	-	-	-
No.: 67 Coarse	60.0	10.07	1640
Fine	40.0	6.71	1055
Cement @: 9.0 Sacks/Yard		4.60	846
Fly Ash @:		-	-
Water: 32.0 Gallons		4.27	267
Air Content: 5.0%		1.35	-
Air Admixture @: 2.25 oz/cwt		-	19.0 oz
Water Reducer @: 3.0 oz/cwt		-	25.4 oz
Polyheed 997 @ 12 oz/cwt		-	101.5 oz
TOTALS:		27.00	3808

TRIAL BATCH TEST RESULTS

DATE MIXED: 02/06/95

Slump: 1.25 in. Air: 4.2%

Unit Weight: 143.2 pcf

Sample No.	Date Tested	Age in Days	Calc Area of Beam	Total Load	PSI	Avg	Remarks
3428C	02/13/95	7	212.67	8092	685		
3428D	02/13/95	7	214.1	8208	690	690	
3428E	02/20/95	14	213.6	9099	765		
3428F	02/20/95	14	217.7	8584	710		
3428G	02/20/95	14	215.6	8740	730		
3428H	02/20/95	14	218 5	8279	680	720	
3428I	03/06/95	28	220.6	8490	695		
3428J	03/06/95	28	222 8	9839	795	745	

Signed By: [signature]
Chris D. Spandau, P.E.
Vice President

For: Kleinfelder, Inc

No 30-1649-07.001

APPENDIX E
NEVADA SPS-2 PCC MIX DESIGN

KLEINFELDER

VALID FOR ALL PCC DESIGNS

[redacted] 6, 1995
[redacted]30-1649-07.001

Mr. John Matich II
Matich Corporation
1371 South La Cadena Drive
Colton, California 92324

SUBJECT: **Concrete Mix Designs**
NDOT Contract #2591

Dear Mr. Matich:

During the period of January 6 through January 13, 1995 various concrete mix designs were performed for proposed use on the subject project.

The coarse aggregate source was identified as Nevada Department of Transportation (NDOT) pit designated 83-6 and the sand source was Silver State Pit (aka Negro Pit).

The cements used were Nevada Cement products - Type 1P and Type II. The pozzolan source was Pozzolanic International Type "F," Bridger. The specific gravities used in the trial batches for the cement and fly ash were: Type 1P 2.95, Type II 3.15 and pozzolan 2.25.

We understand that the aggregate qualification tests have previously been performed and accepted for use on the project. The gradings and specific gravities used in the mixes were as follows:

Test Results

GRADING ANALYSIS - PERCENT PASSING BY WEIGHT

U.S. Standard Sieve Size	Coarse Aggregate Size #4	Coarse Aggregate Size #67	Concrete Sand
2"	100		
1-1/2"	90.6	100	
1"	33.0	100	
3/4"	5.9	96	
1/2"	1.2	56.9	
3/8"	1.0	31.5	
#4		2.4	100
#8			84.7

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GRADING ANALYSIS - PERCENT PASSING BY WEIGHT (Continued)

U.S. Standard Sieve Size	Coarse Aggregate Size #4	Coarse Aggregate Size #67	Concrete Sand
#16			61.4
#30			38.9
#50			13.6
#100			2.3
#200			1.2

Specific Gravity			
Bulk (SSD)	2.61	2.61	2.52
Absorption(%)	1.04	1.66	2.13
Sand Equivalent (Average of 3)	---	---	90
Cleanness Test	75	84	---

Based on the gradation tests presented above, aggregates were combined to the following percentages to meet the grading requirements of Section 706 of the project specifications:

Mix Type	Aggregate Size	Percent of Total
1½" Max	#4	29%
	#67	33%
	Sand	38%
3/4" Max	#67	60%
	Sand	40%

Based on these percentages, the combined gradings for each of the two mix types are as follows:

1½" Max

U.S. Standard Sieve Size	Percentage Passing By Weight	Grading Limits
2"	100	100
1½"	97	87-100
1"	81	65-90
3/4"	71	48-82
1/2"	57	- - -
3/8"	49	39-57
#4	39	30-45
#8	32	23-38
#16	23	15-33
#30	15	0-24
#50	5	4-13
#100	1	1-5
#200	0.5	0-3

3/4" Max

U.S. Standard Sieve Size	Percentage Passing By Weight	Grading Limits
1"	100	100
3/4"	98	80-100
1/2"	74	- - -
3/8"	59	46-70
#4	41	34-50
#8	34	24-42
#16	25	17-34
#30	16	10-25
#50	5	5-15
#100	1	2-7
#200	0.5	0-3

If we can be of any further assistance, please contact our Reno office at (702) 323-7182.

Very truly yours,

KLEINFELDER, INC.

Donald R. Curphey

Donald R. Curphey, P.E.
Senior Engineer

Brand M. Duc

Brand M. Duc
Operations Manager

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